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SHORT-TERM RECALL OF SENTENCES:
CONCEPTUAL REPRESENTATION OR PLAUSIBLE RECONSTRUCTION

by

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ABSTRACT

The present experiments were designed to study the nature of the representation underlying sentence comprehension and immediate recall. It is well-established that long-term recall of verbal materials is based on an abstract, conceptual representation (Bransford & Franks, 1972) in which the surface form of the sentences and the exact wording is largely lost. In contrast, immediate recall of a sentence is typically verbatim. It is, however, unclear at what point in time the abstract representation becomes dominant. Sachs (1967, 1974) found that while immediate recall of a sentence was generally verbatim, when a second sentence intervened, only the gist of the earlier sentence was retained. This finding suggested that an accurate surface representation on which verbatim recall is based is available immediately but is discarded as more information comes in (Fodor, Bever, & Garrett, 1974; Glucksberg & Danks, 1975).

Potter (1985) has proposed that, like longer-term memory, immediate recall is conceptually based. Activated lexical items are mapped onto a conceptual representation using normal speech production mechanisms. In Potter’s synonym substitution task, an incidentally activated word (the lure) which was a synonym of some target word in the sentence often intruded in immediate recall, supporting the hypothesis.

The purpose of the current work was to extend Potter’s work and
examine an alternative explanation of word substitutions in short-term recall. This alternative proposes that the recaller uses activated words in reconstructing the sentence, but rather than being guided by a conceptual representation, the recaller simply creates a plausible sentence from the activated lexical items at hand. In Potter's task, lures which were synonyms of sentence target words also tended to be very high-CLOZE words for that position in the sentence. These experiments adapted Potter's paradigm such that there were two lures for each sentence, a synonym and a high-CLOZE "pragmatic" lure. The synonym lure retained the original meaning of the sentence when substituted for the target word while the pragmatic lure changed the meaning, but preserved the well-formedness of the sentence in general.

The results show that subjects are capable of making pragmatic as well as synonymy lure substitutions. However, pragmatic lure intrusions were never numerically as numerous as synonym substitutions despite being chosen for their high-CLOZE character. These substitutions do not seem to reflect a pure "plausibility" mechanism (independent of original sentence meaning) in sentence recall. Rather, the results suggest that immediate recall is based on a "loose" conceptual representation, one with which both synonym and pragmatic lures are consistent.

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One of the important issues in the study of short-term memory concerns the nature of the representation from which immediate recall is produced. Immediate recall of sentences, be they visually or auditorily perceived, is remarkably accurate. Likewise it is well-established that long-term recall of verbal materials is largely (Bransford & Franks, 1972). However it is unclear at what point in time this change occurs. Sachs (1967, 1974) found that immediate recall of a sentence is typically verbatim, but that only the gist of a sentence is retained if a second sentence intervenes before recall. The question then arises; Is there a qualitative difference in the underlying representation of these two types of recall? While most would agree that long-term memory is based on an abstract, conceptual representation, the nature of the representation on which immediate recall is based is less clear. Phenomena like that demonstrated by Sachs (see Von Eckardt & Potter, 1985 for a summary), have led some to suggest that the immediate representation of sentences is a "surface" representation. The surface representation is maintained for the duration of the clause (or some other theoretical segment), at which point semantic interpretation is completed and a conceptual representation is established. The surface representation is then discarded in favor of incoming information (Fodor, Bever, & Garret, 1974; Glucksberg & Danks, 1975; and Flores d’Arcais, 1978). The existence of a surface representation would allow immediate recall to be verbatim.

Recently a new view has developed in which not only is a conceptual representation immediately available, but there is no surface representation per se. Research by Von Eckardt and Potter (1985), showing that picture probes to sentences are responded to at least as quickly as verbal probes, supports this theory. A conceptual-lexical form of this theory has been proposed and studied by Potter (1985) using a method called synonym substitution which she developed for this purpose.

In a series of experiments using this paradigm Potter has tried to demonstrate that short-term recall is a reconstructive process based on an
abstract, conceptual representation of the meaning of the sentence, normal sentence production mechanisms, and a set of currently activated lexical items. That is, when immediate recall of a sentence is required, it is accomplished by mapping the set of activated lexical items onto the conceptual representation in memory by means of speech production mechanisms. Potter's synonym substitution task demonstrates the distinction between these components of the recall process by manipulating the set of activated lexical items relative to the meaning of the sentence in question. Specifically, subjects are presented with the task of reading a sentence in Rapid Serial Visual Presentation (RSVP), followed by a distractor list, followed by a probe. The subject is required to decide whether or not the probe was in the distractor list and then repeat the sentence. For example, the subject is presented with a sequence like the following:

****** The knight rode around the palace searching for a place to enter.
****** medal booth castle chair turtle ****** BOOTH

The subject is instructed to recall the sentence aloud after deciding whether or not the probe word (BOOTH in this case) was present in the list (YES in this case).

Potter has shown that in recall of sentences like the one above, subjects are likely to substitute the lure (CASTLE) for the target (PALACE) 30 - 40% of the time. Moreover, this is not due to priming within the synonym pairs. This has been demonstrated by is judged more appropriate in one sentence than in the other. For the synonym pair PALACE/CASTLE the sentence shown above would be considered a "GOOD" sentence for synonym replacement, since CASTLE fits the overall conceptual gist of the sentence at least as well as PALACE does and is therefore likely to produce substitution errors. However, in the sentence, "The royal family danced in the palace to the music of an orchestra", PALACE is more appropriate conceptually than CASTLE and should be less likely to produce substitutions. Sentences of this type were designated "BAD" for
substitutions, by hypothesis. Potter has shown that synonym substitutions occur much more frequently in the GOOD sentences, suggesting that the recall process is dominated by a conceptual representation, not merely lexical associations. The lexical items are represented by activation in the lexicon, but they are only attached to the sentence when they are selected during production of the sentence as it is recalled.

The hypothesis tested in the present study contrasts Potter's conceptual model of recall with a surface-based plausibility mechanism in recall. This hypothesis proposes that the recaller uses activated words in reconstructing the sentence, but rather than basing recall on a full conceptual representation of the sentence, the recaller simply creates a plausible sentence using activated lexical items or chunks. To understand the contrast between the two hypotheses, consider the following example:

***** The detective spent weeks looking for the missing observer in the murder case. ***** medal booth witness chair turtle ***** BOOTH

We can expect that, in this situation, subjects will substitute the word WITNESS for OBSERVER a significant portion of the time. Rarely, if ever, will they recall the words MEDAL, BOOTH, CHAIR, or TURTLE as belonging to the sentence. This has been assumed to be due to the fact that none of these words have any conceptual relationship to the sentence in question. However, there remains another possibility. WITNESS is the only word in the list which can be substituted into the sentence in any plausible way. None of the other words would lead to a plausible sentence. Suppose, on the other hand, that the word WEAPON were on the list. It would generate a perfectly plausible sentence if substituted for OBSERVER. If plausibility of the recalled sentence is the controlling factor in recreating a sentence from a set of activated lexical items, one would expect the presence of WEAPON to cause substitutions as readily as the presence of WITNESS.

The purpose of this work was to extend Potter's work and examine this alternative explanation of word substitutions in short-term recall.
EXPERIMENT 1

The purpose of the first experiment was to establish a new set of materials with which the synonym substitution task could be performed while including a plausible or "pragmatic" control lure. In order to do this, two things had to be simultaneously accomplished. First, for each of twenty synonym pairs, one GOOD and one BAD sentence was created. This was in order to replicate Potter's results with new materials. Second, for each of the 20 GOOD sentences, a pragmatic lure was found. The pragmatic lure had to complete the sentence at least as well as, if not better than, the original synonym lure, but complete the sentence with a different meaning. So, for instance, given the example already mentioned with the synonym pair OBSERVER/WITNESS, the sentences would be:

GOOD: The detective spent weeks looking for the missing observer in the murder case.

BAD: Shy Diana was always a silent observer during the lively class discussions.

Notice that the synonym lure WITNESS is an appropriate substitute for the target word OBSERVER in the GOOD sentence but not in the BAD. Notice also that the pragmatic lure WEAPON completes the GOOD sentence as well as the synonym lure WITNESS, but with a different meaning.

Method

Subjects - Twenty MIT undergraduates were paid for their participation.

Materials and Design -
SENTENCES and LURES

For each of 20 pairs of synonymous nouns, one GOOD and one BAD sentence was written. The synonym pairs were taken for the most part from materials previously used by Potter. Each sentence was between 10 and 14 words long. None contained internal punctuation. In addition to the synonym that served as a lure, a pragmatic lure was selected for each of the GOOD sentences. The lures were chosen using a separate group of 28 subjects in a CLOZE procedure. The GOOD sentences were presented to subjects with a blank in the target position. Subjects were instructed to fill in the blank with whatever word they thought best completed the sentence. From 3 to 28 subjects saw each of the sentences used in the final set of materials. An average of 20 subjects saw each item. The lures were chosen from the set of responses given for each sentence. Criteria for selection of a pragmatic lure included (in order of importance);

1. **Response frequency** equal to or greater than the response frequency of the synonym lure for that sentence. Response frequencies for the pragmatic lures selected ranged from 7 - 100%, with a mean of 48%. More significantly, the difference between the response frequency of the pragmatic lure and its respective synonym lure ranged from -38% to 100%, with a mean of 38%. These figures are slightly misleading however, because a negative figure here implies that the synonym lure was a much more common response than the chosen pragmatic control. However, in the three cases with a negative rating, this was deemed acceptable because the synonym lure never exceeded 50% of the total responses. In addition, it was not uncommon for the pragmatic response to be one of a set of responses with the same general meaning, distinct from the meaning of the synonym lure. Thus, the pragmatic lure was representative of the preferred interpretation of the sentence in the Cloze task.

2. **Word frequency ratings** (Francis & Kucera, 1982) with the same range as that of the synonyms and other distractors (roughly between twenty and one hundred instances per million words).
3. Word length no longer than nine letters.

**Distractor Lists and Probes**

A pool of 240 common nouns were taken from Francis and Kucera. The pool included words within a range loosely matched to the frequency of the lures (20 to 100). An attempt was made to include words of varying lengths, again to match loosely the distribution of lengths among the lures.

The sentences, lures, and distractors, as well as the results from the CLOZE procedure, are shown in Appendix A.

**Trials**

Each trial in Experiment 1 consisted of either a GOOD or a BAD sentence followed by a list of four distractors and the synonym lure, followed by a probe word. The four distractors were selected randomly from the pool of 240 words, with the requirement that they have no obvious conceptual relationship to any of the words in the sentence or either of the two lures (the synonym or pragmatic lure). One probe word was assigned to each sentence. In half the sentences, the probe came from the list of distractors already assigned to that sentence (a YES probe response sentence) and in the other half a new word was chosen from the distractor pool (a NO probe response sentence). The synonym lures were inserted in position 2, 3, or 4 within the list. The position was randomly varied throughout the set of 20 sentences, but was held constant across experimental versions.

**Versions**

Two versions of the materials were created, each with 10 GOOD sentences and 10 BAD sentences, counterbalanced between versions. The order of GOOD and BAD sentences was randomly determined with the constraint that half be YES probe sentences and half be NO probe sentences. Although the sentences in each version were different, the word lists and probes were the same. Each version began with a common set of five practice trials. The practice trials contained no lures in the word lists.
Procedure - Each subject saw 20 experimental sentences immediately preceded by 5 practice sentences. The sentences were presented in RSVP on an IBM-AT. Each trial began with a fixation point of three asterisks in the center of the screen. The fixation point remained on the screen until the subject indicated his or her readiness by pressing the space bar. After a pause of 200ms, the sentence was presented one word at a time in the same position on the screen at the rate of 200 ms/word. The first word in the sentence was capitalized and the presentation of the last word included a period. The end of the sentence was followed by a mask of 12 asterisks for 500 ms. Next the distractor list was presented one word at a time. Ten subjects saw the list at 183 ms/word (Group 1) and ten saw the list at 250 ms/word (Group 2). (Half of the subjects in each group saw each version). Following the distractor list a second mask of asterisks was presented for 250 ms. Finally a probe word in capital letters came on for 500 ms. Subjects were asked to decide whether or not they had seen the word in capital letters in the distractor list. If their answer was yes, they pressed the YES key on the keyboard and if their answer was no, they pressed the NO key. Accuracy and response times were recorded for each probe response. The subject then repeated the sentence aloud and the experimenter recorded the response.

Results

General accuracy of sentence recall was high. Accuracy was measured by calculating the percentage of words in each sentence correctly recalled (regardless of order), excluding the target noun. Overall, 92% of the nontarget words were correctly recalled, with no differences between groups (where groups differed only by which version and what distractor list presentation rate they saw). Responses to the probe word were correct on 89% of the trials, again with no differences between groups.

Initial analyses of variance by subject were carried out on the percentage of synonym substitutions made as functions of version and
presentation rate (between subjects). Only the main effect of version was significant, \( F(1,16) = 5.9, p < 0.05 \). The version differences did not interact with any other variables.

The measure of interest was the percentage rate of synonym substitutions (synsubs) in GOOD versus BAD sentences shown in Figure 1. A subject analysis provided a paired t-test comparison of the rates (22% and 8% respectively), \( t(19) = 3.29, p < 0.005 \). An item analysis of the same yielded a \( t(19) = 2.21, p < 0.05 \).

One more measure of possible interest, not shown in Table 1, was the rate of other target errors. That is, how often were target errors made that were not synonym substitutions? This category of errors includes omissions as well as spontaneous, non-lure substitutions and for naming consistency is called other substitutions or othersubs. The othersub rates for GOOD sentences were 10% and 5% for the groups with faster and slower distractor lists, respectively. (Since there was no further interest in the BAD sentences, Bad othersub rates were not tabulated.)

**Discussion**

The results of Experiment 1 replicate Potter's original substitution result with new materials. This is shown by the fact that the GOOD sentences produced significantly more synonym substitutions than their matched BAD sentences.

It is true that the 22% rate of synonym substitutions in GOOD sentences is not as high as that obtained in most of Potter's work (where synsub rates averaged closer to 30%). There are two possible reasons for this. First, some of the present sentences were much more likely to produce synsubs than others, so much so that three sentences never produced any. The present materials had not undergone repeated pilot testing, as had Potter's material, and so were not highly selected. Second, because of the nature of the ultimate goal, *i.e.*, to pit pragmatic lures against synonym lures in the same sentence, it was necessarily harder to create sentences
with as strong a conceptual bias as is possible when only one lure is at stake. Even though there was a lower rate of synsubs, the materials met the requirement that the GOOD rate was significantly higher than the BAD.

It is also worth noting that although there were 36% target errors (combining synsubs and othersubs), overall accuracy of recall for nontarget words was high, with only 8% errors. Thus, subjects were recalling the sentences nearly verbatim, apart from the target word.

**EXPERIMENT 2**

The purpose of Experiment 2 was to test the conceptual-lexical hypothesis against the plausibility hypothesis using the pragmatic control lures taken from the Cloze norms. Specifically, we wanted to know what effect the presence of both types of lures would have on substitution rates. If a conceptual representation is the dominant driving force behind recall, then the pragmatic lure should have no more effect on recall than any of the other distractor words. In such a case one would expect a synonym substitution rate consistent with that previously observed and a pragmatic substitution rate of zero. On the other hand, if the plausible fit of a lure word is the dominant force behind recall one should see substitution rates which reflect the frequency with which the two lures were produced in the Cloze norms. That is, the pragmatic lures should substitute more frequently than the synonym lures.

**Method**

**Subjects** - Twenty MIT undergraduates were paid for their participation.

**Materials and Design** - The materials included the 20 GOOD sentences and 5 practice items from Experiment 1. Each distractor list
included two lures, the original synonym lure and the new pragmatic lure. The lures were placed into the distractor lists at positions 2 and 4. Positions 1, 3, and 5 were filled with the distractor words originally assigned to that sentence. For half the sentences the synonym lure was shown in position 2 and the pragmatic lure in position 4 (SP sentences). For the other half the order of the lures was reversed (PS sentences). Half of the SP and half of the PS sentences were YES probe-type sentences and half were NO probe-type sentences. The order of the sentences and of the positive and negative probes was the same as in Experiment 1. The occurrences of SP/PS sentences were randomized within these constraints. Two versions were necessary to insure that each sentence was seen in both the SP and the PS condition.

Procedure - The procedure was the same as in Experiment 1, except that all subjects saw the distractor list at a presentation rate of 183 ms/word.

Results

As in Experiment 1, the overall accuracy in recall of the sentences was high, with 88% correct recall of nontarget words. On the probe task 85% of the responses were correct.

Synonym and pragmatic substitution rates were 20% and 4% respectively. Paired t-tests by subject and item both showed this difference to be significant. The subject analysis produced a $t(19) = 6.49, p < 0.001$. The item analysis yielded a $t(19) = 4.31, p < 0.001$.

Separate analyses of the effect of lure order on both synonym and pragmatic substitution rates revealed no significant effects. The synsub rate for sentences in the SP condition was 19%, with 22% in the PS condition. The substitution rates for the pragmatic lures were 3.5% in the SP condition and 5.0% in the PS condition (both $F's < 0$).
Discussion

It is clear from the results that the conceptual structure of the sentences did play a role in recall. This is evident from the average synonym substitution rate of 20%. It is also clear from the paired t-test that synonym substitutions were significantly more frequent than pragmatic substitutions. It is less clear whether or not the presence of the pragmatic lures in the lists played any role at all in recall. A strict interpretation of the conceptual-lexical hypothesis does not predict any pragmatic substitutions, so some explanation of the 4% pragsub rate is required. One explanation that would be compatible with the conceptual hypothesis is as follows. If for some reason the original concept of the target word were not encoded, because of inattention for instance, that role in the representation or in the recall process could be filled in with anything available, including the pragmatic lure. This would produce pragmatic substitutions from an otherwise conceptual representation.

EXPERIMENT 3

The purpose of the third experiment was to look more closely at the question of whether or not the pragmatic control lures had any effect in recall. Specifically, did the presence of the pragmatic lure affect the probability of making a synonym substitution? The presence of an alternative completion might, for example increase the general difficulty of the task while not explicitly manifesting itself in recall. Not only might this decrease synonym substitutions, it might also increase other types of errors, for the target word or the sentence as a whole.

If the conceptual hypothesis holds in a strict way there should be no effect of a pragmatic lure on synsubs, other target errors, general accuracy, or even probe accuracy. The pragmatic lure should have no different status than any other distractor word. From Experiment 2 we know this cannot be
the case.

If however, a surface representation is in some way still involved at the
time of recall, perhaps in the form of sentence fragments, the pragmatic lure
could produce either of two problems. There could be a straightforward
competition between target lures which would not affect the general efficacy
of the process but might affect the absolute rate (though the not the relative
superiority) of synonym substitutions. Or, the presence of the alternative
lure (while not directly competing for acceptance because of the previously
established conceptual bias) could result in increased difficulty and noise in
the process. The first possibility would predict a lowered synonym
substitution rate in the presence of a pragmatic lure, but no other changes
in performance. The second possibility could manifest itself in several ways.
By creating general confusion, it could cause greater rates of target errors
(increased synsubs, increased other target errors, or both) or it could raise
overall non-target errors, including probe errors.

Method

Subjects - Subjects were 24 MIT undergraduates. They were paid for
their participation.

Materials and Design - The sentences and the two kinds of lures were
the same as in Experiment 2. Each subject saw the 5 practice sentences
and 20 experimental sentences. There were four versions, each seen by six
subjects. In each version half the distractor lists had YES probes and half
had NO probes. Half the lists included only a synonym lure and half had
both synonym and pragmatic lures. When lures occurred they were in
positions 2 or 4. Half of the time the synonym lure was in position 2 and
half the time it was in position 4. In all there were eight types of sentences
resulting from the combinations of the three factors; probe type (YES or
NO), number of lures (S and P or S only), and lure order (S in position 2 or
4). Probe type was constant across versions; number of lures and lure order
were counterbalanced, in random order.

**Procedure** - The procedure was the same as in Experiment 2.

**Results**

Table 2 shows the main results of Experiment 3. Once again accuracy remained high. Overall sentence accuracy was 87% and probe accuracy was 85%. Synonym substitutions (*synsubs*), pragmatic substitutions (*pragsubs*), and all other target errors (*othersubs*) were analyzed. An initial analysis of variance with version as a variable produced a significant main effect of version on synsubs ($p < 0.02$) but inspection suggested that this result was a materials effect that did not compromise effects of other variables. Therefore, for further analyses, results were collapsed across versions. The overall synsub rate was 20%, the pragsub rate was 5%, and the othersub rate was 13%. It is worth noting that none of the othersubs were spontaneous pragsubs. In other words, the pragmatic lure never appeared in recall when it was not present in the distractor list.

Paired t-tests by subject and by item were run on the difference between synonym and pragmatic substitution rates, for the two-lure sentences only, as in Experiment 2. The analysis by item produced a $t(19) = 3.11$, $p < 0.01$. The analysis by subject produced a $t(23) = 4.48$, $p < 0.001$.

Other analyses were carried out on the effects of the number of lures and the order of lure presentation on five dependent variables: synonym, pragmatic, and other substitutions, recall of non-target words and probe accuracy. None of the main effects or interactions were significant (Figure 2).

**Discussion**

Two things can be concluded from the results of Experiment 3. The first is that in this paradigm, recall appears to be dominated by a conceptual representation of the material in question. The number of
synsubs and the overall number of errors of each kind did not change significantly when a pragmatic lure was added to the distractor list. To intrude with substantial frequency, lures must be conceptually consistent with the original sentence.

The second conclusion is that not only is the presence of a pragmatically-appropriate lure insufficient to produce frequent pragmatic substitution errors, its presence has no effect on any aspect of the recall process that was measured. There was no influence on target recall, general recall, or the accuracy of probe performance.

Both of these conclusions support the conceptual-lexical hypothesis proposed by Potter. However, the presence of the few pragsubs that did occur remains to be explained.

**EXPERIMENT 4**

Experiment 4 was an attempt to determine how soon a conceptual representation of the sentence is available. The original synsub paradigm was designed to probe the conceptual representation of the sentence with pre- or post- sentence lures. However, because of this sequential presentation method, it has been impossible to establish the existence of a full conceptual representation any earlier than 2 or 3 seconds after the completion of the sentence. The intention in Experiment 4 was to place the target and lure in as close temporal proximity as possible by presenting the sentences and distractors simultaneously.

Although we were not at all certain that subjects would be able to perform such a task, we felt the possibilities were interesting enough to warrant an attempt. For instance, simultaneous presentation might change the ratio of pragmatic substitutions to synonym substitutions relative to previous methods because the pragmatic lure would appear at the time of processing the sentence, before an incompatible conceptual representation
had been established.

**Method**

**Subjects** - Thirty-six MIT graduates were paid for their participation.

**Materials and Design** - The materials for Experiment 4 included the five practice sentences and eighteen of the experimental sentences from Experiments 2 and 3. In addition, 18 unrelated filler sentences were created. The filler sentences were created to resemble the experimental sentences in length and form, but not in content. The lures for the experimental sentences remained unchanged, but only two of the non-lure distractors were retained, cutting the distractor list down to three words. Distractor lists were created for the filler sentences by selecting three words for each sentence from the remaining words in the distractor pool mentioned in Experiment 1. None of the words were related to the sentences. Filler sentences for Experiments 4 and 5 are shown in Appendix B.

Each experimental trial contained only one lure (either a synonym or pragmatic lure, but not both). The lure appeared in position 1, 2, or 3 of the distractor list. Lure type (S or P) and lure position (1, 2, or 3) for each sentence were counterbalanced across six versions. In addition, across versions, half of each the synonym and pragmatic lure trials had positive probes and half had negative probes. Positive probe trials always consisted of one of the two distractor words, never the lure itself.

**Procedure** - Each subject saw 41 trials, including 5 practice trials, 18 experimental trials, and 18 filler trials. The stimuli were presented on an IBM-AT computer monitor in RSVP. Each trial consisted of two streams of stimuli appearing simultaneously on two adjacent rows of the computer screen. The center row (#11) contained the fixation point, sentence, mask, and probe. The row immediately above the sentence (#10) contained the
distractor list. For descriptive purposes, words in the sentence are referred to with respect to their distance in words from the target word. That is, the target occurred at position T in the sentence. The word immediately preceding the target was called T-1. The word immediately following the target was T+1, and so forth. The timing of the presentation of the sentence and the list was adjusted during pilot work. Durations (and synchronization) of the two streams of information were made long enough to allow subjects to perceive both the sentence and the list of words, but short enough to discourage eye movements between the them (see Figure 3 for a timeline depicting an example presentation sequence).

Each trial was initiated by the subject pressing the space bar. A fixation point of 1 sec duration appeared and was followed by a blank of 250ms. The blank was immediately followed by the first word in the sentence. Each word in the sentence up to T-3 was presented for 250ms. Sentence words T-3, T-1, and T+1 were presented for 350ms. Words T-2, T, and T+2 were presented for 300ms. All words after T+2 were presented for 250ms. The list of words above the sentence appeared at intervals either 900ms before, 250ms before, or 400ms after the onset of the target. Each list word lasted for 300ms and the intervening intervals of 350ms were filled by blanks. (Each list word began 100ms after the onset of one word in the sentence and ended 50ms after the onset of the next word.) At the completion of the sentence a 183ms mask of 8 asterisks was followed by the probe word for 500ms. The first letter of the sentence and the entire probe word were presented in capital letters. The last word of the sentence was accompanied by a period. As in previous experiments, the subject was required to indicate whether the probe word had been present in the distractor list and then recall the sentence aloud. The experimenter recorded the response.
Results

Three types of target errors were measured: 1) synsubs and pragsubs, 2) spontaneous synsubs and pragsubs, and 3) all other target errors (generally including omissions, non-lure intrusions, etc.). Spontaneous substitutions are those intrusions of the lure which occur in the absence of the lure itself. In this case spontaneous synsubs could occur in the trials containing only pragmatic lures and spontaneous pragsubs could occur in those trials containing synonym lures. The measurement of spontaneous substitutions provides baseline rates of substitutions which are not directly due to the lure’s presence. These baseline rates allow the calculation of substitution rates which are due solely to the lure, called corrected syn/prag subs, where:

1) corrected synsubs = synsubs - spontaneous synsubs,
2) corrected pragsubs = pragsubs - spontaneous pragsubs.

Results of all target errors for both lure types are shown in Figure 4. As in earlier experiments, the uncorrected substitution rate was higher for the synonym than the pragmatic lures (21% compared to 15%). An analysis of variance by subject showed this to be only marginally significant, F(1,35) = 3.38, p < 0.074.

The effect of position also proved marginally significant. Having a lure in the first position produced a 14% substitution rate. The second position produced 23% substitutions and the third position produced 17% substitutions, F(2,70) = 2.65, p < 0.078.

The interaction of lure (S or P) and position (1,2, or 3) produced no significant effect; S1=14%, S2=27%, S3=23%, P1=15%, P2=19%, and P3=10%, F(2,70) = 1.36, p < 0.26 (see Figure 5).

The marginal difference between the synonym and pragmatic substitution rates seems to be due largely to the propensity to spontaneously substitute synonym lures more frequently than pragmatic
lures. After adjusting for spontaneous substitutions, no significant effect of lure type on overall substitution rates remained (see Figure 6). The corrected synsub rate was 17% and the corrected pragramsub rate was 14%. An analysis of variance by subject on the corrected rates resulted in an F(1,35) = 0.45, p < 0.51.

Other target errors were 8% for synonym sentences and 10% for pragmatic sentences.

**Discussion**

There are two kinds of conclusions to be drawn from Experiment 4. One is methodological and general in application and the other is theoretical and specific to this line of research.

The first conclusion is that it is possible to probe the representational status of a sentence with lures during the comprehension process. Subjects are in fact able to successfully read a sentence while monitoring a distractor list. And, the make-up of the distractor list can be manipulated, apparently, to produce errors in subject performance. These performance errors can then be used to form inferences about sentence comprehension. This should broaden the range of psycholinguistic paradigms available to the researcher.

The second conclusion drawn from Experiment 4 concerns the conceptual-lexical theory so far examined in this paper. The results of Experiment 4 differ from previous results by the high rate of pragmatic substitutions made: a rate equal to that of the synsubs after corrections for spontaneous intrusions are made. The fact that the substitutions of synonym and pragmatic lures were statistically equal suggests that a different mechanism is allowing intrusions when the lures are presented with, rather than after, the sentence. It appears that lure intrusions are being made less on the basis of the conceptual role of the target in the sentence and more on the conceptual status of the sentence fragment preceding the target. That is, it is possible that the lure, rather than being
substituted for the target after comprehension has occurred, actually preempts the encoding of the target altogether. This implies that during comprehension, the construction of a conceptual representation is "loose" enough to allow conceptual "detours" based on pragmatically plausible lures.

The marginal appearance of a lure X position effect on the type of substitutions made also supports this view. The fact that pragmatic substitutions occurred as often or more often than synonym substitutions when the lure preceded the target, but dropped to almost one-third the synsub rate when presented after the target, suggests that the conceptual representation of the sentence is both labile and rapidly updated.

One other possibility remains with which to explain, if not the equality of synsubs and pragsubs in Experiment 4, its absence in Experiments 2 and 3. The previous experiments had no condition in which the pragmatic lure appeared alone. Recall that, while the pragsub rate was nowhere near that of the synsub rate, neither was it at zero, hovering instead around 5%. It is possible that if presented alone, the pragmatic lure might intrude at a rate equal to the synonym lure, even in the original synsub paradigm. This possibility will be addressed in Experiment 5.

**EXPERIMENT 5**

The purpose of Experiment 5 was twofold. First, we wanted to replicate our results in Experiments 2 and 3 using the pragmatic and synonym lures in separate, non-competing trials. Second, we wanted to test the hypothesis that the nonsignificant but suggestive interactive pattern of substitutions observed in Experiment 4 was due to preemptive intrusions of lures preceding the target combined with reconstructive substitutions of lures following the target. If this were the case we would expect to see high CLOZE pragmatic lures substituted more frequently than synonym lures if
presented before the sentence and vice versa if presented after the sentence.

**Method**

**Subjects** - Subjects were two groups each of twelve MIT undergraduates. They were paid for their participation.

**Materials and Design** - The experimental sentences, filler sentences, practice sentences, and lures were the same as those used in Experiment 4. Again, half of the experimental trials (9 items) contained only a synonym lure while the other half contained only a pragmatic lure. In addition, two extra distractor words were added to the distractor lists from Experiment 4 in order to bring the lists up to five words in length (including the lure). The new distractor words were placed in positions one and five of the lists, allowing the lure to retain the same counterbalancing rotation through positions 2, 3, and 4 as in Experiment 4. Probe type (yes or no) was preserved from Experiment 4.

**Procedure** - Each subject saw a total of 41 items, including 5 practice items, 18 filler items, and 18 experimental items. The subjects were divided into two groups of 12. One group was designated the **BEFORE** group and the other was designated the **AFTER** group. The only difference between the two groups was the order of occurrence of the distractor list within each trial. For the Before group the distractors (and lure) were presented before the sentence. The After group saw the sentence first, followed by the distractor list. The probe word occurred at the end of each trial for both groups.

**The Before Group** - For the Before group each item began with a fixation point of asterisks in the center of the screen. The fixation point remained on the screen until the subject indicated his or her readiness by pressing the space bar. This initiated the presentation of the distractor list, one word at a time in the same position on the screen at the rate of 183
ms/word. A mask of 12 number signs immediately followed the last distractor and remained on for 183 ms. The sentence was then presented at the rate of 200 ms/word. The first word of the sentence began with a capital letter and the last word was presented with a period. A second mask of 500ms duration followed the sentence. The trial ended with the presentation of the probe word in capital letters for a duration of 500ms. At this point, subjects decided whether or not the probe word had occurred in the distractor list, pressed the key which corresponded to their answer and finally repeated the sentence aloud. The experimenter recorded the response.

The After Group - The procedure for this group was identical to that for the Before group except that the distractor list was presented after the sentence. Each subject saw a sentence at 200 ms/word, followed by a 500ms mask, followed by a distractor list at 183 ms/word, followed by a 183ms mask and a 500ms probe. The response protocol was the same.

Results and Discussion

Lure substitutions, spontaneous substitutions, and other target errors were measured for the before and after conditions (see Figure 4).

In the Before condition, uncorrected synonym and pragmatic substitution rates were 24% and 10% respectively, F(1,11) = 6.02, p < 0.03. Correcting for spontaneous substitution rates of 12% and 3% gave a synsub and pragsub rates of 12% and 7% (see Figure 6). An analysis of variance by subject showed no significant difference, F(1,11) = 0.74, p < 0.41.

In the After condition, uncorrected synonym and pragmatic substitution rates were 18% and 6%, F(1,11) = 11.0, p <0.007. Correcting for spontaneous synsubs of 10% and pragsubs of 1%, gave a corrected synsub rate of 8% and a corrected pragsub rate of 5%. Again the significant effect of lure type went away with the corrections. An analysis of variance by subject produced an F(1,11) = 0.31, p < 0.59.

An analysis of corrected substitution rates of the two types of lures
between the two groups (Before and After) yielded no significant difference, \( F(1,22) = 0.194, p < 0.664 \).

The results from Experiment 5 are surprising. Rather than affecting the prassoc rate, the presentation of the pragmatic lure by itself indirectly affected the synassoc rate. By allowing the circumstances to exist in which spontaneous synsubs could be measured and used as a baseline, the corrected synassoc rate for these materials was virtually cut in half. Statistically, it was reduced to the size of the previously ignored prassoc rate.

This result alone brings the conclusions of the four previous experiments into question. An interesting, though somewhat baffling result is the presence of a significant interaction of lure type and experiment in producing spontaneous substitutions, \( F(1,57) = 4.86, p < 0.01 \). While spontaneous synsubs were frequent in Experiment 5, in Experiment 4 they diminished to a level comparable to spontaneous prassoc subs i.e., very small (see Figures 7 and 8). It is possible to dismiss the difference in one or the other type of target error (either the increase in pragmatic subs or the decrease in spontaneous synonym subs) in Experiment 4 relative to Experiment 5 by invoking the incomparability of the experimental tasks. However, it is more difficult to explain away the simultaneous presence of these differences with the same reasoning. It is difficult to imagine, given any of the current theories, a process that could increase one type of target error while simultaneously decreasing another.

**GENERAL DISCUSSION**

The preceding experiments were designed to distinguish between conceptually-driven versus pragmatically-driven immediate recall of sentences. Contrary to the predictions of Potter's conceptual-lexical model, pragmatic substitutions did occur and they occurred systematically in only
those cases where the pragmatic lure was present in the distractor list. How can this have happened if the representation is truly conceptual?

One explanation concerns methodology. In retrospect it became apparent that the procedure used to collect the pragmatic norms was at odds with the intended theoretical question. Two opposing views of memory were being examined. The first, Potter’s conceptual-lexical hypothesis, is based on a message-level representation of the verbal material in question. When recall occurs, it is pre-planned on the basis of all the available information. On the other hand, if an uninterpreted (non-message-level) representation is the basis of recall, with some sort of plausibility function controlling the output, there is no reason to think all the material in question is available simultaneously to constrain plausibility. Material should only be available as its position in the recall process is reached.

If these were truly the assumptions of the two hypotheses, then it is quite possible the pragmatic norms were collected improperly. When subjects were given the Cloze sentences and asked to complete them with the best-fitting words, they had access to the entire sentence while composing their answers. This procedure presupposes the message-level view. As such it could not be expected to shed perfect light on the recall process if it actually were based on a surface representation which allows access to the items in a sentence only as they are produced serially in recall. The plausibility of a lure in this context would be identical to its transitional predictability. With this in mind a “corrected” set of pragmatic norms were taken after Experiment 3. In the new norms, subjects were given only the sentence fragments preceding the targets (which were again replaced by blanks). One group of subjects was given the CLOZE task of simply filling in the blank and a second group was required to make forced-choice selections between the pragmatic and synonym lures. Both groups were told that the next word would not necessarily complete the sentence. (Mean response frequencies for all three sets of norms are shown in Appendix A.) The new CLOZE norms based on sentence fragments
produced very low transitional probabilities for both lures. This is not surprising considering the fact that it was the original set of CLOZE responses upon which the stimuli were based. As such the "corrected" set of norms are still not strictly appropriate to the question asked. For whatever reason, none of the norms, new or old, showed particular predictive power for the lure substitutions.

The rest of this discussion will focus on the conceptual-lexical model. There are at least three ways pragmatic substitutions could occur within the context of a conceptual representation. Two possibilities involve a failure of the normal mechanisms of encoding and retrieving material and the third possibility involves a redefining of the scope of errors considered conceptual in nature.

The first scenario assumes an encoding failure (for whatever reason) of the target word, such that the original conceptual representation of the sentence has a "hole" in it. In this case, the lure plays no part until retrieval begins. Of course, the question arises whether or not a deep, message-level representation can exist with holes. It is possible that reaching the message level presupposes some minimum level of comprehension, perhaps enabled by a conceptual "smoothing function" such that missing information need not halt the comprehension process (e.g., "The detective spent weeks looking for the missing SOMETHING in the murder case"). Upon retrieval, the production mechanism might simply fill the hole with another activated lexical item. In this case the retrieval process has access to both lures simultaneously. Given the absence of a biasing target word, it seems reasonable to assume that the criterion of selection in this situation would be the plausibility of the lure within the context of the entire sentence (as reflected in the complete-sentence CLOZE norms).

In the second scenario, some small percentage of the time the subject also fails to encode the target word during presentation of the sentence. However, the lure becomes involved during the initial encoding rather than later during recall. During presentation of the distractor list the lure is
picked out and "plugged" into the conceptual gap left by the missed target. Upon recall, the subject produces the original sentence with what looks like a lure substitution but is actually more akin to the "preemptive"-appearing substitutions produced in Experiment 4. Under this model, assuming that the assimilation of the lure into the sentence is immediate, the proportions of encoding errors resulting in synsubs and pragsubs should be about equal, depending largely on which lure is encountered first. Relative plausibility or conceptual fit should play no role since the comprehension process would latch onto the first acceptable possibility, without regard to future possibilities.

There are two concerns with both of these "failure"-based explanations of pragsubs. The biggest concern is the simple fact that after corrections for spontaneous lure intrusions in Experiments 4 and 5 the synsub rate was statistically no larger than the pragsub rate. Calling errors based on synonym lures reflective of the normal process and errors based on pragmatic lures reflective of a fall-back process, when the "normal" theory itself is founded on the synonym errors is questionable at best. In addition, it would be odd to propose a model of pragsubs based on a general failure in comprehension which would affect only the target word, given the high overall accuracy rate.

The third possible scenario for explaining pragsubs within the scheme of the conceptual-lexical hypothesis does not assume a failure of the normal process. Instead it merely involves the redefinition of what is and is not considered a conceptual-based error. Upon examination of the pragmatic lures and their corresponding sentence completions, the question becomes, "How dissimilar in meaning do two propositions have to be before they are considered conceptually unrelated?" It is true that none of the pragmatic lures share the same relationship to the sentence and target as do the synonym lures. Of course, it is also true that the pragmatic lures are NEVER (by definition) unrelated to the sentence and rarely (by necessity) completely unrelated to the target. The possibility arises that a conceptual
representation of the sentences exists, either as a single "fuzzy" unit into which related concepts can be intruded, or as a conglomerate of conceptual fragments with which related concepts can be interchanged. An analogous phenomenon which might help illustrate this notion appears in the visual memory literature, namely work done by Loftus (1979) on eye-witness reports. Subjects who saw scenes of a given conceptual framework could be induced to make false-alarm recognition errors of conceptually appropriate, yet non-synonymous objects.

The weight of the experiments in this paper seem to favor this last model of lure intrusions, based on a loose conceptual representation of the sentence. Although the results would not have been predicted by the conceptual-lexical model of Potter, in retrospect they seem compatible.
Figure 1. Synonym substitution rates in Experiment 1
Figure 2. Error rates as a function of lures in Experiment 3
"match"
D 1

"exhibit"
D 2

"luck"
D 3

T - 3
"were"

T - 2
"in"

T - 1
"the"

T
"display"

T + 1
"at"

Time in ms. (0 = onset of target word)

Figure 3. Example sentence and list presentation sequence; Experiment 4
Figure 4. Uncorrected target errors in Experiments 4 and 5.
Figure 5. Uncorrected substitution rates as a function of position in list for Experiment 4.
Figure 6. Corrected target errors in Experiment 4 and 5
Figure 7. Uncorrected target errors in Experiment 4 and 5 as a function of list presentation relative to sentence presentation
Figure 8. Corrected target errors in Experiment 4 and 5 as a function of list presentation relative to sentence presentation.
BIBLIOGRAPHY


These are the materials of Experiments 1, 2, and 3. The trio of words on the left are the target word, synonym lure, and pragmatic lure respectively. The sentence shown in the middle is the "good" sentence and the sentence on the right is the "bad" sentence. The number shown in parentheses after each sentence is the number of words in the sentence. All sentences are between 10 and 14 words in length. The list of words beneath each sentence is the set of distractor words and probe word (in capital letters) for that sentence. Depending on the trial, either one or two of the distractors shown were replaced by lures.

1. DISPLAY EXHIBIT CLOSET
   The new paintings were in the display at the rear of the gallery. (13)
   The new clothes were in display in the window of the store. (18)
   invasion, pill, match, luck, sheep        SHEEP

2. CHAIR SEAT PURSE
   The usher at the theater seat found Joan's chair for her with a smile. (13)
   Joan bought a chair for her husband at the auction yesterday. (11)
   beach, herd, bubble, soil, phase        HERD

3. REPLY ANSWER CALL
   The distraught lover of the house waited for his sweetheart's reply all day long. (11)
   The thoughtless remark provoked a sharp reply during the class discussion. (11)
   studio, rain, star, priest, chamber     SOUND

4. CARPET RUG ICE
   Johnny slipped on the carpet as he raced out of the house. (11)
   The handyman tacked down the carpet before taking his lunch break. (11)
   license, estate, noun, hit, layer       CRITIC
5. INSTRUCTOR The principal defended the unpopular instructor to the county school board. (11)

The nervous horse would not allow the riding instructor to touch him. (12)

engine, winter, salvation, signal, index

GOLD

6. HOUSE HOME FAMILY

The young man left his house when he moved to the big city. (13)

The realtor sold the house in a record time of only six hours. (13)

guest, mountain, pound, wage, memory

WISH

7. LETTER NOTE DRINK

Tim passed a letter down the row to George at the movie. (12)

The lawyer relayed his concerns in a letter to the committee. (11)

muscle, youth, risk, sum, target

MUSCLE

8. SHIP BOAT GRASS

The old man sat down on the ship next to the picnic basket. (13)

The captain maneuvered the ship out of range of the enemy fleet. (12)

cotton, soul, key, talent, pride

COTTON

9. MYTH LEGEND BAR

Steve first learned about the local myth from his brother's friends. (11)

Steve first learned about gods and goddesses in a myth told at school. (13)

valley, foam, button, aim, pot

BIRD

10. WATER LAKE PARK

The couple strolled leisurely around the water behind their two dogs. (11)

Sam played games in the cool water with the other neighborhood kids. (12)

theme, doctrine, merit, loan, map

KNOB
11. PALACE
CASTLE
KING
The tired knight rode swiftly to the palace with his message.
(11)

The royal family often gave balls in the palace during the winter.
(12)

heel, request, weather, stair, mold

12. CELLAR
BASEMENT
SHED
The Wilsons organized their tools in the cellar with great care.
(11)

The Wilsons stored their wine collection in the cellar with great care.
(12)

horizon, voter, tank, horn, curtain

13. BUNK
BED
FOOD
Billy liked to shared his bunk with the dog whenever he could.
(12)

The soldier slept on an iron bunk inside the drafty barrack.
(11)

refund, giant, fee, carrier, owner

14. POISON
VENOM
SKIN
The Indians of the desert commonly used snake poison in their religious ceremonies.
(13)

The scientist often handled poison in his studies of the nervous system.
(12)

embassy, flood, mile, brush, tractor

15. COAT
JACKET
SHIRT
Danny ruined his new coat on the first day of school.
(11)

The watchman exchanged his sweater for a coat when the weather turned bitter.
(13)

bundle, fork, code, rebel, sphere

ROBE
16. OBSERVER WITNESS WEAPON The detective spent weeks looking for the missing observer in the murder case. (13)
Shy Diana always became a silent observer during the lively class discussions. (12)

potato, mercy, essay, journey, profit TRICK

17. STOVE OVEN APARTMENT The lazy bachelor had not cleaned his stove in over a year. (12)
The harried housewife pulled the frying pan off the stove before it burned. (13)

habit, angle, tail, sketch, occasion ANGLE

18. AUTHOR WRITER ACTOR Jim was a top author with one of the most popular shows on TV. (14)
Each week the talk show interviewed the author of the current bestseller. (12)

string, gang, village, marine, dawn STYLE

19. BELL ALARM CROWD The noise of the bell echoed wildly through the cavernous building. (11)
The ringing of the bell echoed softly through the peaceful valley. (11)

wealth, curve, net, uncle, title UNCLE

20. LANE ROAD CRIMINAL The anxious police officer followed the criminal lane up the steep canyon. (11)
Betty Lou skipped down the country lane after school without her shoes. (12)

cigar, rhythm, monument, steel, storm RHYTHM
APPENDIX B

These are the filler sentences created for use in Experiments 4 and 5. The list following each sentence corresponds to the distractor words assigned to that sentence. In Experiment 4 only two of the distractors shown were used, plus one lure. In Experiment 5, four of the distractors were used, plus one word. Again the word in capital letters is the probe word for that sentence. None of the experimental sentences or lures were changed from the previous experiments.

1. The astronomers knew the name of every star the boy pointed to. fault mixture tile entry guest MIXTURE

2. The sharp knife sliced easily through the frozen block of vegetables. throat excuse noise ridge priest BALANCE

3. Todd had trouble keeping his neckties from slipping off of their hanger. orbit stone baby driver request BABY

4. The spectators watched in awe as the jets zoomed by. mercy economy wit thread iron JAIL

5. Richard had never seen a pelican before his trip to the zoo. historian tape ratio sauce aunt DIET

6. Shelley could not stand the summer heat without a cooling fan. tent guard neighbor concrete bigot NUT

7. Mike collected old green bottles as a hobby in his free time. forge delight fruit panel puzzle RIDER

8. The rusty cannon sat buried in the thick weeds beside the old statue. ruffle root organ trap snap SADDLE

9. Rebecca put a bright candle in the window for the holidays. whisper tension arrow loop drawl LOOP

10. The squirrel dropped an acorn down a hole in a hollow tree. dozen cry campaign flash socket CRY


11. The irate cabdriver blew his horn at the careless pedestrian. jungle fabric maid rocket sitter MAID

12. The cardboard boxes cluttered the floor of the new office for months. sword salary gift ton copper GENIUS

13. The famous statesman was given the keys to cities all over the world. detour verse wheel label graph LABEL

14. Little Cindy refused to open her eyes for fear of the dragon. mare noon gate soap pest NOON

15. The new lamp on the table boasted the latest in Italian design features. thigh pencil scale fight sled FOLK

16. Anita sent a postcard of the beach to her coworkers while on vacation. widow ideal rifle plate veranda ONSET

17. Kevin took his girlfriend to the scenic cliffs overlooking the ocean. vapor palm glance veteran harbor GLANCE

18. The worried parents took their baby to the doctor at the first sign of illness. variety season yarn brick crystal BRICK
<table>
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<th>Pragmatic Lure</th>
<th>Complete sentence Cloze ( n = (3-28, \text{ mean 20}) )</th>
<th>Sentence Fragments Cloze ( n = 11 )</th>
<th>Forced Choice ( n = 37 )</th>
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</thead>
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Table A. 1. Pragmatic norms.

Numbers given correspond to the percentage of subjects who completed each sentence with the respective category.