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Transfer and Forgetting: Interpretive Shifts and Stimulus Reinstatement

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A series of experiments are reported investigating the consequences for transfer and forgetting of various types of changes in semantic interpretation of stimuli. Experiment 1 employed homographic stimuli whose meanings were changed or remained the same from List 1 to List 2 in an A–B, A–D paradigm. There was a greater amount of negative transfer when the interpretation of the stimulus was changed. Experiments 2, 3, and 4, using nonhomographic stimuli, indicated that the type of change rather than change per se might determine the amount of transfer. All experiments consistently demonstrated that an important component of forgetting is the inability to reinstate the appropriate stimulus interpretation, and this was related to the dominance of the most recent encoding of the stimuli.

In the case where successive responses are attached to the same stimulus (A–B, A–D), theoretical accounts of negative transfer and forgetting have tended to focus on the relationship between the two response systems. Concepts like reproductive inhibition (McGeogh, 1942), unlearning (Melton & Irwin, 1940), generalized competition (Newton & Wickens, 1956) and response set suppression (Postman, Stark, & Fraser, 1968) are all basically mechanisms designed to explain how some responses might serve to reduce the availability of others.

Recently more interest has been shown in the relationship between the two successive sets of *stimuli*. For example, Martin (1972, pp. 59–84) has suggested that when a subject learns an A–B pair and subsequently learns A–D, either he retains them both in the form of A_B–B and A_D–D, or A–B is erased and the subject retains only A–D. The basic premise is that a particular stimulus may serve as a stimulus for only one response. According to this view, the way to minimize negative transfer (which is presumably caused by the intrusion and erasure of B while the subject is trying to learn A–D) is to change the encoding of the stimulus—that is, from A_B to A_D. Changing encodings should also reduce forgetting of the initially learned pair since it eliminates the need to "dump" (Martin's term) previously learned relationships. This reduction in forgetting would also depend, of course, on whether or not the previous encoding of the stimulus can be reinstated (Martin, 1971; Melton, 1963; Tulving & Thomson, 1973) at the time of the retention test. Thus, there are two reasons that a subject might forget in this situation: (a) The correct response has been erased by subsequent events, or (b) the appropriate stimulus has not been reinstated. In general, this view tends to emphasize that responses are under the control of relatively specific stimuli.

Most of the studies designed to test implications of such an encoding variability account of negative transfer and forgetting have equated the concept of encoding with that of stimulus selection (e.g., Martin, 1968; Merryman & Merryman, 1971; Schneider & Houston, 1968; Williams & Underwood, 1970). However, Martin and others (e.g., Bower, 1972, pp. 85–123) have

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emphasized the wide applicability of the idea that the same nominal stimulus may be variably encoded on successive encounters, and the general trend in the literature is for terms such as code and encode to receive relatively broad definitions. Certainly one of the most interesting features of the encoding variability notion is its potential usefulness in generating ideas about the relationship between memory and changes in the semantic interpretation of stimuli. This was the subject of the present experiments.

Experiment 1

A powerful way of influencing the interpretation of a stimulus is to manipulate the semantic context in which it occurs (e.g., Bransford & Johnson, 1973, pp. 383–438; Light & Carter-Sobell, 1970; Schvaneveldt, Meyer, & Becker, Note 1). For example, Light and Carter-Sobell have demonstrated that if a word like *jam* is studied in the context of *strawberry jam* it will be correctly recognized more often in the same context than in a context such as *traffic jam*. The present experiment was a study of transfer and forgetting in which an attempt was made to vary the interpretation of stimuli through a similar manipulation of semantic context.

The subjects learned two successive lists of paired associates. The stimuli were adjective-noun phrases. The responses were nouns. A sample pair is *cherry pit–battle*. Furthermore, the stimulus nouns were words with multiple meanings so that when modified by an appropriate adjective, their meaning from the first to the second list could (a) remain the same (*cherry pit–degree*), (b) remain relatively similar (*olive pit–degree*), or (c) change (*tiger pit–degree*). There was also a control condition in which both the adjective and the noun were unrelated to the first-list stimuli (e.g., subjects learned *cherry pit–battle* in List 1 and *savings bank–degree* in List 2).

On the basis of an encoding variability view, the amount of negative transfer during the learning of the second list, and the amount of subsequent forgetting of List 1 responses, should be less in the *tiger pit* than in the *cherry pit* condition, since the former condition represents a clear and easy shift in interpretation of the stimulus nouns from List 1 to List 2. The *olive pit* condition provides information about the degree of shift in semantic interpretation of the stimuli necessary to affect recall.

The prediction of superior recall of the first list when the semantic interpretations of the stimuli are changed holds only for the case in which the subject is provided with both the List 1 adjective and List 1 noun as cues at the time of List 1 recall. This cueing condition was contrasted with one in which subjects received the List 1 nouns alone as recall cues. A failure to recall B (the List 1 response) should occur if the nominal A (the noun stimulus) is interpreted in the wrong way. In the present study, a recall attempt with the homographic noun alone should be particularly difficult when the stimulus has recently been given a very different interpretation. Therefore, presenting the noun alone as a recall cue should produce the greatest number of recall failures in the case of the greatest change in interpretation of the stimuli from List 1 to List 2. Thus, the addition of the type-of-recall-cue variable was intended to provide a direct test of the assumption that a major cause of forgetting is failure to reinstate the original interpretations of the stimulus terms.

Method

Design and materials. The design of the experiment was a 4 × 2 factorial; the variables were (a) type of semantic relationship between List 1 and List 2 stimuli and (b) type of recall cue. Four different groups of subjects learned the same first list (A–B) composed of 12 paired associates with adjective-noun phrases as stimuli and common nouns as responses. The second list a subject received was determined by the particular semantic relationship condition. In the first three conditions, the noun stimulus remained the same and adjectives were either the same or different. Thus, in the A_i–D condition, the adjective was identical; in A_s–D, the adjective was new but the basic meaning of the phrase was similar to that in List 1; and in A_d–D, the adjective was new and the basic meaning of the phrase was different. The second list responses in all conditions were composed of a new set of nouns. Two independent sets (1 & 2) of materials which satisfied the above relationships were constructed. In the fourth, control, condition (C–D), three subgroups learned one list from Set 1 and one from Set 2. After learning the A–B list from Set 2, 1/3 of the subjects in this condition received the A_i–D list from Set 1, 1/3 the A_s–D list, and 1/3 the A_d–D list. Similarly, following learning of the A–B list from Set 1, 1/3 of the subjects received the A_i–D list from Set 2, 1/3 the A_s–D list, and 1/3 the A_d–D list. This procedure was adopted so that performance on the same lists could be compared when they followed either unrelated (C–D) or related (A_i–D, A_s–D, or A_d–D) first lists.

For each set of materials, 12 ambiguous nouns (homographs) were selected with the restriction that when modified by different adjectives they have different meanings, two semantically similar and one semantically different. Examples are: *marching band, jazz band, rubber band; iris bulb, tulip bulb, light bulb.* One of the two semantically similar phrases was randomly chosen as the first list stimulus term, and the second similar phrase served as the second list stimulus in A_s–D. The semantically different phrases always served as second list stimuli.

The responses were common nouns with Thorndike and Lorge (1944) frequencies of AA. The stimulus–response pairs were formed randomly with the restriction that no obvious meaningful relationship existed between the response and either first- or second-list stimuli. The stimulus adjective was typed in lowercase letters, whereas the stimulus noun and the response were always in uppercase letters.

The second experimental factor was type of recall cue. Following interpolated (List 2) learning, a random half of the subjects in each of the four semantic relationship conditions were given the first list stimulus phrases (adjective-noun) as cues to recall the first list responses. The other half of the subjects received only the nouns in the first-list stimulus phrases as cues.

Procedure. Learning was by the study–test method with the adjective-noun phrase serving as the stimulus term on test trials. Materials were presented via a slide projector. The presentation rate was 2 sec on both study and test trials. Four different presentation orders were randomly generated for the study and the test trials of each of the lists.

The List 1 criterion was 10/12 correct responses. The appropriate second list (i.e., A_i–D, A_s–D, A_d–D, or C–D) was then presented for six study and six test trials.

Immediately after the second list, one of two forms of retention tests (adjective-noun or noun alone) for the first list was administered. The appropriate recall cues were presented one at a time at a rate of 3 sec and subjects attempted to give the correct first list response. Four random orders of the cues were used equally often across all conditions. A subject-paced test followed the paced test but the results were highly comparable to the paced test, and they will not be reported here.

Subjects. The subjects were 96 introductory psychology students at the State University of New York. They were run individually and were assigned randomly within successive replications of the conditions.

Results[1]

First-list learning. In an analysis of trials to criterion, neither the main effects of semantic relationship and type of cue nor their interaction were significant (overall $\bar{X} = 3.91$), indicating the experimental groups were comparable in initial learning ability.

Second-list learning. There were no differences in performance of the subjects on the A_i–D, A_s–D and A_d–D lists when they were learned following an unrelated list ($F < 1$). This was determined by comparing the relevant subgroups in the A–B, C–D condition. Therefore, we assume that any differences in performance on List 2 reflect transfer effects rather than differences in list difficulty.

The mean number of correct responses given in the six trials of List 2 learning appear in Figure 1. Only A_d–D resulted in significant negative transfer relative to C–D [Dunnett's test, $t(4, 92) = -2.67$, $MS_e = 86.04$].

First-list recall. Figure 2 shows the mean number of correctly recalled first-list responses. There was a main effect of semantic relationship, $F(3, 80) = 14.16$, $MS_e = 4.12$, a main effect of recall cue, $F(1, 80) = 12.73$, and an interaction of these two factors $F(3, 80) = 7.67$. Further analyses indicated that overall recall in C–D was superior to that in A_i–D, $F(1, 40) = 22.91$, $MS_e = 3.96$. This is, of course, typically found when stimuli remain the same on two successive lists. In addition, the A_i–D and A_s–D conditions did not differ. Thus, when the interpretation of the stimulus was changed, but remained relatively similar to the original interpretation, recall was affected very little.

Of particular interest was a comparison of A_s–D and A_d–D conditions. In both cases,

[1] An alpha level of .05 was used throughout this series of experiments. In addition, since sets of materials did not interact with the major variables of interest, results are collapsed across materials in these experiments.

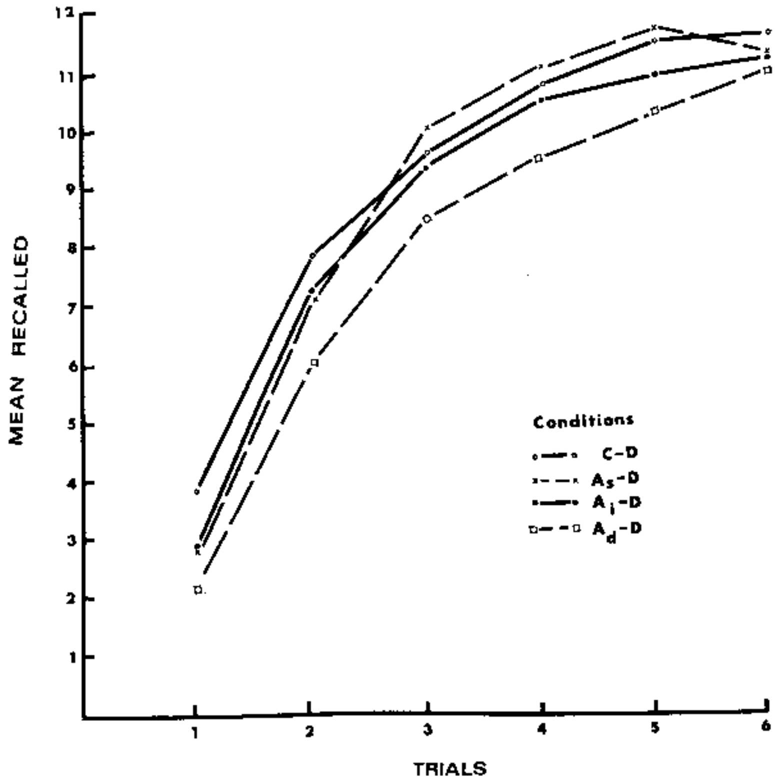

FIGURE 1. Acquisition curves for List 2, Experiment 1.

the interpretation of the noun was changed from List 1 to List 2; however, in the case of A_d–D this change should have resulted in a greatly different interpretation. The important finding was a significant interaction of semantic relationship and recall cue, $F(1, 40) = 13.70$, $MS_e = 4.27$. As indicated in Figure 2, while recall in A_d–D was superior to A_s–D when the recall cue was an adjective-noun phrase, performance in A_d–D was inferior to that in A_s–D when the recall cue was the noun alone.

In other words, these data provide evidence for less forgetting with a major change in interpretation of the stimulus noun if, and only if, the original interpretation of the stimulus is given at the time of recall. In the noun-alone conditions, a major change in interpretation was especially detrimental for recall. Presumably this is because the second-list interpretation dominates at recall. The overt errors were examined to obtain data relevant to this. If, in the noun-alone condition, the stimulus interpretation from the second list persists, then the number of

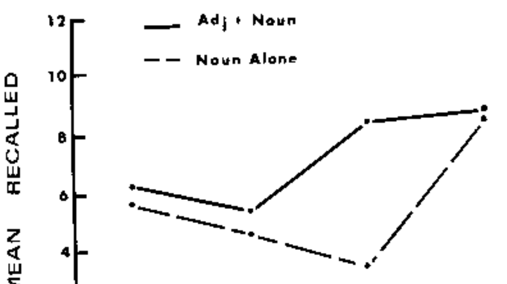

FIGURE 2. Mean correct recall of List 1, Experiment 1.

TABLE 1

Total Number of Correctly and Incorrectly Paired List 2 Response Intrusions During Recall of List 1, Experiment 1

Recall cue	Semantic relationship			
	A_i–D	A_s–D	A_d–D	C–D
Adjective-noun				
Correctly paired	2	14	2	0
Incorrectly paired	2	2	0	1
Noun alone				
Correctly paired	8	16	26	0
Incorrectly paired	6	2	5	1

second-list response intrusions should be higher with the noun-alone condition as compared to the adjective-noun condition. The error data shown in Table 1 show such a pattern. Furthermore, in the noun-alone condition there was a particularly large number of List 2 intrusions in the A_d–D condition.

Discussion

According to the encoding variability hypothesis, negative transfer should be reduced with changes in stimulus interpretation. The present data do not support this prediction. When subjects were given a good opportunity to change their functional encoding of the stimuli from the first to the second list (A_d–D), negative transfer was not reduced, but rather increased. This failure to reduce negative transfer with shifts in stimulus encoding has been found in other studies (Davidson, Schwenn, & Adams, 1970; Goggin & Martin, 1970; Williams & Underwood, 1970). The results of both the Davidson et al. study and the present study indicate specifically that semantic shifts increase negative transfer.

If semantic shifts produce negative transfer, perhaps by introducing confusion among alternative interpretations, it follows that constraining the interpretation of a stimulus might reduce negative transfer. Thus, adjective-noun phrases as stimuli may result in less negative transfer than stimuli composed of either component alone. This might explain why our A_i–D condition produced relatively weak negative transfer. While this might have been due to a lack of sensitivity with only 12 subjects per condition, negative transfer in A–B, A–D is usually robust. Likewise, Davidson et al. failed to find significant negative transfer in an A–B, A–D condition in which the stimulus interpretation was maintained from List 1 to List 2 with a sentence context. It may be that the more the subject's interpretation of the stimulus can be constrained by embellishing the context in which it occurs (such as by adding an adjective), the less likely he will be to change the interpretation while learning the second response. Again, this argument suggests that negative transfer is at least partly a consequence of changes in or competition among interpretations or elaborations of the stimulus. Thus as encoding stability is introduced, negative transfer may be reduced.

With respect to forgetting, the present data clearly demonstrate that recall failures may occur because of a failure to reinstate the appropriate semantic stimulus conditions. The relatively large amount of forgetting in A_d–D with the noun-only cue was eliminated by the presentation of the full adjective-noun cue. In addition, the substantial number of recall failures in A_d–D with the noun-alone cue was accompanied by a relatively large number of intrusions of second-list responses. These overt errors suggest that failure to reinstate the first interpretation is related to the persistence of the second interpretation at the time of the test.

The following three experiments were designed to extend the results of Experiment 1 and to follow up on some of its implications. Experiments 2 and 3 were run concurrently, but for clarity will be discussed separately. Experiment 4 was a replication of Experiment 3.

Experiment 2

There were two major questions of interest in Experiment 2: First, is negative transfer and/or forgetting of List 1 reduced by constraining the interpretation of a stimulus? A condition involving two successive lists with the same noun stimuli (*flame–moment, flame–system*) was compared to a condition in which an adjective was added to the nouns (*dying flame–moment, dying flame–system*). There was also a control group corresponding to each condition, in which the stimuli were unrelated in the two lists. We assumed that a more specific or constrained interpretation would be given to the noun in the case where it was modified by an adjective, and that the subject would be less likely to change this interpretation from List 1 to List 2 than in the case with the single noun stimuli. During List 2 learning, a stable interpretation might reduce confusion between List 1 and List 2 encodings of the stimulus and hence reduce negative transfer. Furthermore a consistent interpretation of the stimulus should minimize the difficulty of reinstating the original interpretation on a later test of recall of List 1, reducing retroactive inhibition. (See also Hasher & Johnson, 1975, for a discussion of this point.)

The second question was how general are the effects of changes in semantic context? In the A_d–D condition of Experiment 1, modifiers were added to homographs in order to determine the basic meanings of the nouns (e.g., *cherry pit* vs. *tiger pit*). That is, modifiers were primarily definitional in function. Commonly, however, stimuli rather consistently signal one basic referent, but the aspect which is most salient may change with new information. The most important thing about a political figure at one time might be that he or she is conservative and at another time that he or she is crooked. Therefore, in Experiment 2, nouns which were not specifically selected for homographic properties were used. The question was whether a change in an aspect or an attribute of a stimulus (*dying flame, spreading flame*) rather than a change in the basic referent would affect transfer and memory relative to a condition in which the attribute of the stimulus was not changed from List 1 to List 2 (*dying flame, dying flame*).

Method

Two sets of 12 paired associates were constructed for each of the following five conditions: (a) noun alone/A–D (*flame–moment, flame–system*), (b) noun alone/C–D (*flame–moment, lettuce–system*), (c) adjective-noun/A–D (*dying flame–moment, dying flame–system*), (d) adjective-noun/C–D (*dying flame–moment, bitter lettuce–system*), and (e) adjective-noun/A_{arb}–D (*dying flame–moment, spreading flame–system*). The "arb" subscript in the fifth condition stands for arbitrary adjectives. These were defined as adjectives which sensibly modified the noun in question without creating bizarre meanings. This same criterion was used to select the adjectives used in List 1 in all adjective-noun conditions. (Additional examples of nouns modified by arbitrary adjectives are *captive gorilla, playful gorilla; borrowed ax, rusty ax; weary clown, amateur clown.*)

Materials were balanced so that an equal number of subjects in A–D and the corresponding C–D conditions learned the same first and second lists from each set of materials. In both sets of materials, the responses were common nouns that had no obvious relationships to the stimuli. Two sets of responses were used with each set of stimuli, and these were equally distributed across subjects within each experimental treatment.

The procedure was essentially equivalent to that used in Experiment 1, except in this case materials were presented via a memory drum, all items were typed in lowercase letters, and the List 1 recall test following List 2 was presented at a 4-sec rate. All subjects were tested with the List 1 nouns alone.

The subjects were introductory psychology students who were run individually and who were assigned to conditions in randomized blocks of the experimental treatments for a total of 16 subjects per condition.

Results

Analyses were conducted to parallel the two questions posed above. First, what is the effect of adding an adjective to the stimulus? This question requires comparisons among noun alone/A–D, noun alone/C–D, adjective-noun/A–D, and adjective-noun/C–D. There were no significant differences among these conditions in trials to criterion on List 1. However, subjects learning lists with adjective modifiers took an average of 6.25 trials to learn as compared to 4.41 trials for subjects learning lists with single noun stimuli, $F(1, 60) = 3.74$, $.05 < p < .10$, $MS_e = 14.51$.

The List 2 learning curves are given in Figure 3. An analysis of the mean total correct over the six learning trials indicated that the two A–D conditions showed negative transfer relative to the C–D conditions, $F(1, 60) = 11.63$, $MS_e = 19.48$, and that the adjective-noun conditions were inferior to the noun-alone conditions, $F(1, 60) = 5.4$. Contrary to our expectation, adding an adjective somewhat increased negative trans-

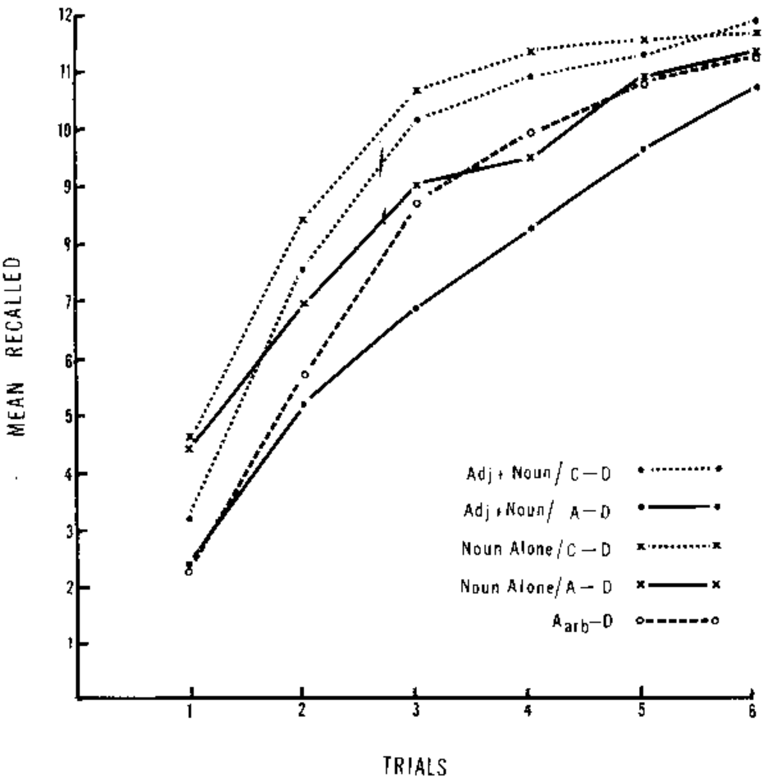

FIGURE 3. Acquisition curves for List 2, Experiment 2.

fer; however, the interaction of type of stimulus (noun alone vs. adjective-noun) with semantic relationship (A–D vs. C–D) was not significant, $F(1, 60) = 1.15$.

The mean correct List 1 recall scores are given in Table 2. Subjects in the A–D conditions recalled less than those in the C–D conditions, $F(1, 60) = 24.49$, $MS_e = 4.94$. The interaction between type of stimulus and semantic relationship, $F(1, 60) = 7.28$, indicates that, as predicted, retroactive inhibition was reduced by adding adjectives to the stimuli.

TABLE 2

MEAN CORRECT LIST 1 RECALL

Stimulus type	Semantic relationship A–D	C–D
Experiment 2		
Noun alone	5.25	9.50
Adjective-noun	5.88	7.12
Experiment 3		
Necessary modifier	2.38	9.12
Arbitrary modifier	2.62	7.12

Our second question was what is the effect of changing from one arbitrary noun modifier in List 1 to another in List 2? The three conditions of interest were adjective-noun/A–D, adjective-noun/C–D and adjective-noun/A_{arb}–D. There were no differences among these conditions in mean trials to criterion on List 1. As can be seen in Figure 3, relative to no change in an adjective-noun stimulus, changing from one arbitrary but meaningful adjective to another decreased negative transfer. Subjects in the A_{arb}–D condition performed more poorly than those in the C–D condition, but only the A–D versus C–D comparison was significant, $F(1, 45) = 9.07$, $MS_e = 129.55$.

The mean List 1 recall scores for the A–D, C–D, and A_{arb}–D conditions were 5.88, 7.12, and 2.62, respectively. The A_{arb}–D subjects recalled fewer items than did the A–D subjects, $F(1, 45) = 17.20$, $MS_e =$

4.91, indicating that changing adjectives increased forgetting of List 1.

Discussion

The recall of List 1 data are fairly clearcut and conform to the picture given in Experiment 1. Changes in interpretation of stimuli, including changes in the aspect of a referent to which an individual attends, increased forgetting. Presumably, with a change in the interpretation of the stimulus, the subject is less likely to recover his original interpretation at the time of the test. Reducing the chances that the stimulus will be reinterpreted during List 2 learning by constraining the meaning (by adding an adjective) also reduced retroactive inhibition (RI) relative to the standard noun-alone condition. However, it should be noted that a substantial part of this reduced RI came from increased forgetting in the adjective-noun/C–D condition relative to the noun alone/C–D condition.

The transfer data present a somewhat more complicated picture. Whereas in Experiment 1 a change in interpretation such as from *strawberry jam* to *traffic jam* produced more negative transfer than the corresponding A_r–D condition (*strawberry jam, strawberry jam*), there was a tendency in Experiment 2 for a change (*dying flame, spreading flame*) to produce less negative transfer than the corresponding A–D condition (*dying flame, dying flame*).

It appears that the very slight tendency in Experiment 1 for the A_s–D condition to be superior to the A_r–D condition was magnified a bit in Experiment 2. Inspection of the A_s–D materials from Experiment 1 suggests that they consisted of a variety of types of items. Some were quite likely to involve changes in referents (*golf ball, soccer ball; olive pit, cherry pit*) and some were more like the A_{arb}–D items of Experiment 2 (*plastic ruler, metric ruler; tailored suit, tweed suit*). Therefore, comparing across these two experiments, it appears that both the amount and direction (relative to no change) of the effect of changing semantic context of a stimulus will depend on the type of change. While shifts in attention to another possible property of the same referent may be beneficial in learning a new response (much as suggested by the encoding variability hypothesis), major shifts in basic interpretation appear to be detrimental. The A_{arb}–D subject may be able to profit some from the previous processing of the stimulus from List 1 (as a consequence of differentiation, generating images, or other kinds of elaboration), offsetting somewhat the negative effects of confusion or associative interference. On the other hand, a major shift in interpretation produced a marked disadvantage. Possibly, processing one meaning of a stimulus (*strawberry jam*) shortly before another (*traffic jam*) considerably alters the aspects of the second meaning which the subject considers in learning the second list. If the availability of the more salient aspects of the second referent were depressed, the subject might be expected to have a harder time developing stable relationships between stimuli and responses in learning the second list.

Experiment 3

Experiment 3 was designed to develop the point, mentioned in the discussion of Experiment 1, that failure to reinstate the first interpretation of a stimulus may be related to the persistence of the second interpretation at the time of the test. Assuming that changes in the attended aspect of a referent influence forgetting, does the type of change matter? In Experiment 3, a change from arbitrary to arbitrary modifiers (*dying flame, spreading flame*) was compared to a change from arbitrary to necessary modifiers (*dying flame, hot flame*). Necessary adjectives are defined as those that are essential to or inherent in the intended meaning of the noun, whereas arbitrary adjectives are defined as those that are neither necessary nor bizarre and can sensibly modify the noun. Our reasoning was that if failure to reinstate the first interpretation of a stimulus is related to the persistence of the second interpretation then more forgetting should be produced when the second interpretation involves a very salient or dominant aspect of the referent, such as a necessary or inherent property. Under these conditions, the second interpretation should be particularly hard to

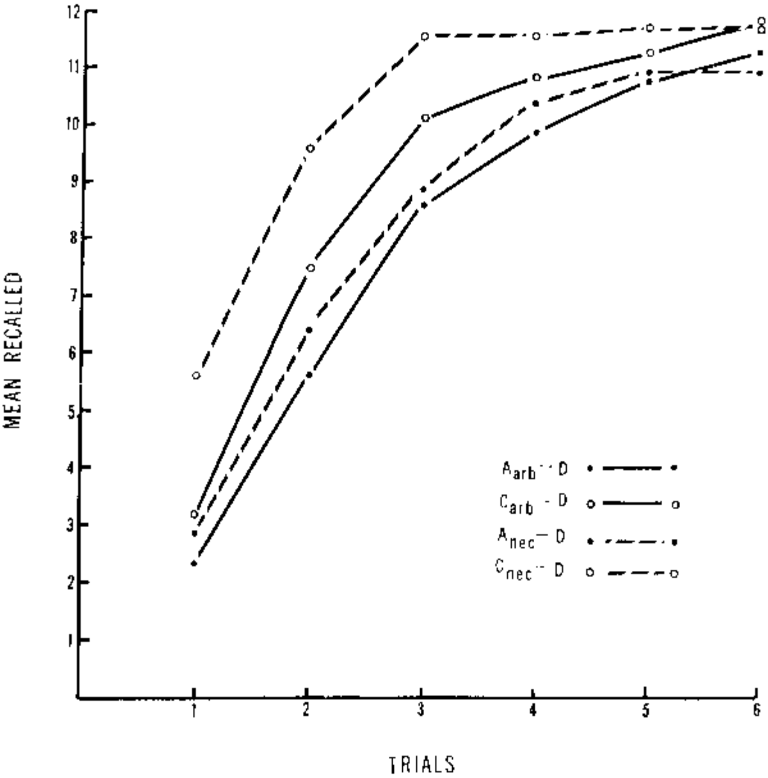

FIGURE 4. Acquisition curves for List 2, Experiment 3.

set aside when the subject is presented with the noun alone as a cue on a retention test.

Method

Two groups, in conditions adjective-noun/A_{nec}-D (*dying flame, hot flame*) and adjective-noun/C_{nec}-D (*dying flame, leafy lettuce*), were run concurrently with those of Experiment 2. (Additional examples of nouns modified by necessary adjectives are *hairy gorilla, sharp ax, funny clown.*) The procedure was identical to that in Experiment 2. The performance of these groups is compared below with the previously discussed adjective-noun/A_{arb}-D and adjective-noun/C_{arb}-D conditions.

Results

The four conditions did not differ in trials to criterion on List 1. The List 2 learning curves are shown in Figure 4. Both the Trials × Semantic Relationship and Trials × Type of Modifier interactions were significant, $Fs(5, 300) = 5.43$ and 3.53, respectively, $MS_e = 1.81$. These interactions indicate that there was significant negative transfer in the A–D conditions relative to C–D and that lists with necessary modifiers were learned more quickly than lists with arbitrary modifiers. Although there was a slight tendency for the negative transfer to be greater in the case of necessary adjectives, neither the Semantic Relationship × Type of Modifier nor the Semantic Relationship × Type of Modifier × Trials interaction was significant.

The recall scores for List 1 are given in Table 2. Subjects in the A–D conditions recalled less than those in the C–D conditions, $F(1, 60) = 145.47$, $MS_e = 3.48$. As expected, the Type of Modifier × Semantic Relationship interaction, $F(1, 60) = 5.81$, indicated that retroactive inhibition was greater when the shift in modifier from List 1 to List 2 involved a necessary as opposed to an arbitrary adjective.

EXPERIMENT 4

Method

Experiment 4 was a replication of the four conditions from Experiment 3. Subjects were run for six trials on List 1, six trials on List 2, and then received a recall test for List 1 with the noun-alone cue, followed by a second recall test with the adjective-noun cue. Stimuli were presented via an overhead projector, and subjects wrote their responses on test trials. Groups of 2 to 6 subjects were randomly assigned to the four experimental conditions. There were 16 subjects per condition.

Results

List 2 acquisition curves showed the same basic pattern as in Experiment 3, and this time the interaction of semantic relationship, type of modifier, and trials was very close to significant, $F(5,\ 300) = 2.53$, $MS_e = 1.65$, with a value of 2.65 required for significance at the .05 level. A three-way interaction would suggest that negative transfer was greater for the A_{nec}–D group than for the A_{arb}–D group.

The mean level of performance on the final trial of List 1 ranged from 10.62 to 11.87. Because of the greater variability among terminal levels of performance on List 1 with the fixed trials instead of trials to criterion procedure, recall was evaluated by computing loss scores. Each subject's performance on the first recall test (noun cue) was subtracted from his score on the final trial of List 1. The means of these loss scores are shown in Table 3. Again, subjects in A–D conditions recalled less than those in C–D, $F(1,\ 60) = 34.02$, $MS_e = 8.37$. Whereas in Experiment 3, RI was greater in the necessary than in the arbitrary conditions, this time the Type of Modifier × Semantic Relationship interaction was not significant; however, the results were in the same direction.

Table 3 also shows the mean gain in number correct from the first (noun cue) to the second (adjective-noun cue) recall test. It appears that the A_{nec}–D condition profits more, relative to its control, than does the A_{arb}–D condition when the first-list adjective is reintroduced. Although the interaction of Type of Modifier × Semantic Relationship was not significant, this pattern is what would be expected if introducing necessary adjectives in List 2 produced a more dominant interpretation as compared to introducing a new set of arbitrary adjectives.

Overall, the pattern of Experiment 4 agrees with that of Experiment 3. Probably

TABLE 3

MEAN LOSS AND GAIN SCORES, EXPERIMENT 4

Measure and List 2 modifier	Semantic relationship A–D	Semantic relationship C–D
Mean loss ($OL - R_1$)		
Necessary	6.75	2.06
Arbitrary	5.56	1.81
Mean gain ($R_2 - R_1$)		
Necessary	3.62	1.38
Arbitrary	1.88	.94

Note. OL = Score on final trial of List 1; R_1 = Recall 1 (noun-alone cue); R_2 = Recall 2 (adjective-noun cue).

the greater variability in performance with a group testing procedure resulted in a less than optimally sensitive design.

GENERAL DISCUSSION

The amount of negative transfer when a new response is learned to an old stimulus is evidently complexly determined. The present results suggest that the amount of negative transfer in a standard noun-alone condition (*flame–moment, flame–system*) may depend on the specific types of relationships between stimulus interpretations generated by subjects for successive lists. Our attempt to increase the chances that the stimuli would be interpreted exactly the same way in the two lists (by adding an adjective to constrain the meaning of the noun, for example, *dying flame, dying flame*), tended to increase negative transfer. The implication is that changes in semantic interpretation should reduce negative transfer.

However, while comparing across experiments must be done with some reservations since materials (especially homographs vs. nonhomographs) and procedures varied, the present results suggest an interesting pattern which current views of negative transfer cannot account for. In Experiment 2, there was a tendency for changes in the aspect of a referent (*dying flame, spreading flame*) to produce less negative transfer than no change (*dying flame, dying flame*). In contrast, in Experiment 1 marked changes in assignment of basic meaning (*cherry pit, tiger pit*) produced more negative transfer than did no change (*cherry pit, cherry pit*).

Thus, it is as if small changes in semantic interpretation allow the subjects some opportunity to reduce associative interference, while at the same time some stability of encoding allows subjects the opportunity to build on to what they have already acquired. On the other hand, large changes may produce confusion from competition among very different interpretations. Or, it is possible that those characteristics of a meaning which are most useful in connecting stimuli and responses are somehow inhibited by recent activation of a completely different meaning of the same nominal stimulus. This could happen, for example, if the most salient features of a concept like *traffic jam* were less likely to occur to the subject after having recently seen a concept like *strawberry jam*. Whatever the mechanism of negative transfer, changing the referent of a stimulus clearly does not automatically change an A–B, A–D paradigm into an A–B, C–D paradigm.

Overall, the present data consistently demonstrate that reinstatement of the semantic interpretation of a stimulus is important for remembering. Rather subtle changes in the aspect of a referent attended to, as well as marked changes in assignment of basic meaning of a stimulus, will produce forgetting. In addition, reinstatement of the original interpretation by presenting a full cue (adjective-noun recall cue from Experiment 1) decreased forgetting, as did increasing the chance that the subject would adopt a stable meaning across both lists (adding an adjective in Experiment 2). Finally, there was some evidence that the more salient or dominant the last interpretation of a stimulus, the more difficult it was to get back to a prior interpretation of the stimulus (Experiments 3 and 4).

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