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Congruency Effects in Part-List Cuing Inhibition

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In demonstrations of part-list cuing inhibition, subjects who are shown a subset of studied list words recall fewer noncue words than subjects not shown such part-list cues. We propose that part-list inhibition is governed in part by an incongruency principle: Inhibition occurs to the extent that part-list cues induce a retrieval framework different from that used to encode list items. In Experiment 1, word lists were studied followed by a test of free recall either without cues, or with cue words serially organized to be either congruent or incongruent with the order of studied items. In Experiments 2–4, cues consisted of every second study item in the original presentation order (congruent ones) or reordered to form famous names or familiar idioms that had been hidden in the study list (incongruent cues). More part-list inhibition was observed with incongruent cues than congruent cues in all 4 experiments.

Examples of retrieval inhibition are pervasive. Demonstrations that attention to one or more items can inhibit access to others in memory range from the disruption of color naming (Stroop, 1935) to interference in reason generation (Hoch, 1984; cf. Peynircioğlu, 1987, for a review). Some of the more counterintuitive examples involve part-list cuing inhibition in which subjects are asked either to generate target material (words from a category) or recall items (words from a presented list) and are given a subset of the material, or part-list cues, purportedly as hints. Frequently, the part-list cues have the opposite effect; fewer noncue targets are generated or recalled in the presence of the part-list cues than in their absence. This effect has proven challenging for theories that postulate a recall process guided by interitem associations (e.g., Anderson, 1972).

Explanations of part-list inhibition have generally relied on notions of associative interference and response competition. However, we believe that such explanations have neglected another principle useful for understanding human memory performance: Memory retrieval depends upon people using the same or a similar organizational framework during retrieval as they had used for learning the items originally. This principle predicts part-list inhibition to the extent that part-list cues capture attention and induce people to adopt a different framework during retrieval than they had developed during learning. The experiments we report test the second part of the hypothesis, which we call the *incongruency principle*. We attempt to demonstrate that part-list cues can reduce recall by inducing a retrieval set that is incongruous with the organization of the items adopted during learning.

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In the part-list cuing paradigm, first studied by Slamecka (1968), subjects are presented with a list of words that they are asked to recall after a brief retention interval. Recall is tested either by free recall without cues or with a subset of the list words (usually chosen randomly) presented as part-list cues. The frequent finding is that slightly more noncue words are recalled on average without cues than in the presence of part-list cues. Part-list inhibition has been observed in a variety of circumstances: with lists of categorized items (e.g., Slamecka, 1972), with paired associates (Mueller & Watkins, 1977), with recall periods of up to 10 min (Roediger, Stellon, & Tulving, 1977); and even when the cues consist of items not shown at study (Roediger et al., 1977).

One sense in which the congruency between cues and list organization affects recall has long been recognized. The amount of inhibition observed seems to depend on the extent to which cues span the categories comprising a study list. Cues can improve performance, as measured by the total number of noncue items recalled, whenever they remind subjects of a category that they otherwise would not have recalled (Slamecka, 1972; Tulving & Pstoka, 1971). However, cues usually have a small but reliable inhibitory effect on the mean number of words recalled per category (Mueller & Watkins, 1977; Roediger, 1973; Rundus, 1973; Slamecka, 1968; Sloman, 1991). The present experiments show that part-list inhibition depends on congruency with respect to relations other than common category membership. In Experiment 1, we ask whether part-list inhibition will be sensitive to the relative temporal order of words shown at study and as test cues; in Experiments 2–4, we ask whether the inhibition would be enhanced if the meaning of words used as cues were changed between study and test.

Theoretical Background

Nickerson (1984) provides a thorough review of the various hypotheses that have been offered to account for part-list cuing inhibition. While some of these surely account for some

of the findings, he concludes that none explain all of them. Two hypotheses are of particular relevance to us.

A first hypothesis is embodied in a model of free recall proposed by Rundus (1973). His model formalizes the idea that people perseverate in thinking about part-list cues, that once a cue-word enters working memory, it tends to remain there and thus blocks other (target) items from coming to mind. The model relies on five assumptions. First, lists are encoded hierarchically in memory so that each item is linked to one of a small number of subjective units that span the list, with each subjective unit linked to a list cue. No direct links exist between items or between subjective units. Second, the probability of recall of a subjective unit depends on its strength of association to the list, according to:

$$P(\text{Recall unit } i) = RQ_i \div \sum_j RQ_j. \quad (1)$$

Here, RQ_i is the associative strength between subjective unit i and the list cue, and j spans all subjective units on the list. An individual item can be recalled only if the subjective unit containing it has been recalled. The probability of recalling item i given recall of its corresponding unit has the same form as recall of a unit except that the RQ's represent the associative strength between each item and the unit containing it and j spans all items connected to that unit. Third, the retrieval process is viewed as analogous to a process of sampling with replacement. In particular, already recalled items may be sampled again covertly, although such duplicates would be edited out and not expressed. Fourth, the act of recall strengthens the association between an item or a unit and its retrieval cue. Finally, reading a part-list cue is assumed to be tantamount to recalling an item inasmuch as it strengthens that item's association to the cue. Because its associative strength is thus increased, each part-list cue is more likely to be covertly retrieved repeatedly, and this increases the likelihood that subjects will quit attempting recall before sampling and recalling noncued items. Evidence for and against this hypothesis has been reported elsewhere (cf. Basden, Basden, & Galloway, 1977).

Rundus's model implies order independence of the cues. That is, given a sample of items to be used as part-list cues, their order of presentation should not influence the amount recalled. Because the RQ of each item will be increased regardless of its serial position, and because the probability of recall is governed solely by these RQ's according to the ratio rule, the amount of part-list inhibition observed should be independent of cue order. Our experiments question this supposition.

A second hypothesis, closer to our own, proposes that part-list cues disrupt recall strategies (Basden et al., 1977; Brown, 1968; Brown & Hall, 1979). During free recall the optimal retrieval strategy, barring exhaustive search, is to reinstate and exploit whatever strategy was used to encode items. Retrieving items using cues compatible with the list as organized during encoding maximizes the likelihood of retrieval. When no cues are provided by the experimenter, subjects must generate their own and performance depends on their memory for their encoding strategies. If part-list cues are present and used to aid recall, item recall will be guided by associations to these cues so that the order in which items are accessed will be governed by chance associations between cues and targets rather than by more principled strategies closer to those that subjects used during encoding. According to the strategy disruption hypothesis, the part-list cues disrupt retrieval by forcing a serial recall order that is inconsistent with the subjective organization of the list.

The importance of the consistency between the serial order of part-list cues and of the study list can be illustrated with an experiment by Basden (1973). He trained subjects on a list of 30 words, with the order of words varied each time, until they could free recall at least 21 of them. They then received seven study-test trials on a second list. Later, free recall of the first list was tested either in the presence or absence of 10 part-list cues. As cues, each subject received every second word from the first 19 output positions of their final acquisition trial's recall protocol. In contrast to the normal inhibition effect, subjects cued with these congruent part-list cues recalled significantly more of the 20 critical items (11.56) than those who were not cued (8.94).

The facilitation Basden observed is consistent with most models of part-list cuing (e.g., Raaijmakers & Shiffrin, 1981; Rundus, 1973). Suppose that subjects had grouped the study list into ordered sets of two to four words that served as subjective units for recall. Because the cues in Basden's experiment probably spanned the set of subjective units, the likelihood is high that the cues reminded subjects of a subjective unit that they would not otherwise have recalled. The best measures of the subjective organization of a list come from the ordering of words on the final recall protocol after a series of trials on that list (cf. Sternberg & Tulving, 1977). By taking every second word from that protocol, Basden increased the chances that the cues would include a member of each subjective unit. According to our interpretation (and Basden's), the cues facilitated access to items by reminding subjects of the various subjective units (see also Blake & Okada, 1973; Reardon, Polzella, & Brown, 1975).

We propose a modified disruption hypothesis. First, we believe that part-list cues disrupt more than serial recall order (see Peynircioğlu, 1989, for examples of part-list cuing inhibition without disruption of recall order). Any sufficiently large incongruency between the retrieval framework suggested by part-list cues and the framework used to encode targets can disrupt retrieval. In our Experiments 2–4, we predict that incongruency of meaning will cause more inhibition than can be ascribed to the serial order of cues. Second, ascribing inhibition completely to disruption of conscious strategies as opposed to more automatic retrieval processes seems unwarranted. We believe that a preplanned (and more effective) recall process may be disrupted or preempted by part-list cues because they enlist a recall framework that does not match the memory trace or traces searched for, and this need not be a conscious selection of a new recall strategy. On the other hand, we recognize that the part-list cuing effect could be dubbed strategic simply because subjects might be able to choose not to cue retrieval this way.

Experiments consistent with our view are reported in Park (1980; and summarized by Roediger & Neely, 1982). Park showed that encoding factors play a critical role in part-list inhibition. For example, he found part-list inhibition when

words were presented in a categorized list but part-list facilitation when the same words were embedded in sentences. If part-list inhibition is a consequence of the congruency between cues and the organization of items at encoding, then encoding factors should influence the amount of inhibition we observe as much as retrieval factors.

The experiments that follow include incongruent cue conditions in which we expected to observe appreciable amounts of inhibition relative to free recall with no cues. They also include congruent conditions in which cues were chosen whose relative serial order was identical to their order at study. If serial order was the primary determinant of subjects' list organizations, these conditions should show no inhibition relative to the no-cue conditions, and possibly even facilitation. If, however, a shared relative serial order was not sufficient to enlist a retrieval framework more congruent with subjects' encoding framework than subjects were able to enlist in the no-cue conditions, then some inhibition might be observed. Factors causing part-list inhibition other than congruency could also be responsible for any inhibition observed in the congruent conditions. Our predictions, therefore, are that inhibition in recall will be observed in the incongruent conditions relative to both the no-cue and the congruent conditions. We will report tests of these predictions for each experiment individually and, in the General Discussion section, for data combined across our four experiments.

Experiment 1

Our experiments attempt to show that one factor governing part-list inhibition is the relation between the cues and the material being recalled. The first experiment examines the role of serial order of the recall cues, using a manipulation similar to Basden (1973), but one that additionally includes a condition in which we expect part-list inhibition. Inhibition in a congruent condition, in which part-list cues consist of every second word of the study list, is compared with inhibition in an incongruent condition, in which cues consist of a random selection of list items. A related effect of congruency between cues and study material has already been reported (Reardon et al., 1975), but not in the context of part-list inhibition.

Subjects studied a list of common words and soon after were tested for free recall, either with no cues or with part-list cues ordered so as to be either congruent or incongruent with the studied order of the words. Congruent part-list cues consisted of every second word from the study list in order. Incongruent cues were the same words, but their order was scrambled relative to the study list. So that primacy and recency effects in serial position would work against our hypothesis, neither the first two nor the last two words of the study list were used as incongruent part-list cues. To ensure that exactly the same set of part-list cues in the same order was used in the congruent and incongruent conditions, the manipulation was achieved by changing the order of words in the study-lists of the two groups.

Method

Subjects studied then recalled each of three different lists of words. Each list consisted of 24 common words presented on index cards for 3 s each; after each list's presentation, subjects counted backwards by threes or fours for 65 s (to minimize short-term memory involvement) and then tried to free recall the just-presented list, either with no cues, with congruent cues, or with incongruent cues. In the no-cue condition, subjects were instructed to write down as many words as they could remember from the last list shown. Part-list cued subjects were asked to read through the cue words because they might help them to recall the other words and then to recall in writing as many words from the list as possible, though they need not write words that already appeared as cues. The 12 congruent cues consisted of every second word from the original study list (i.e., words appearing in the first, third, fifth serial positions [and so on] in their original order). Exactly the same 12 cue words in the same order were used in the incongruent condition; however, by shuffling the study list of these subjects, these words were chosen from randomly distributed positions throughout the middle 20 serial positions. By this arrangement, the cue and target (to be recalled) words were identical for congruent and incongruent conditions. Cues appeared down the left-hand column of a sheet of paper, and subjects were told that they could write their responses in any order anywhere on the sheet. They were given as much time as they desired for recall.

Forty-eight Stanford University introductory psychology students, participating for course credit, were tested in groups of 8 or fewer. Each student was tested on three lists, one in each condition. Each condition was tested an equal number of times in each serial order (first, second, and third). Three different lists of 24 words of intermediate recall difficulty were chosen for each position from free recall norms (Christian et al., 1978). The same list was always presented in a given position, but the experimental condition for that list's recall was varied across subjects. Six different orders of the three conditions were each used an equal number of times. To help segregate the study-test trials on the three lists, about 8 min was spent between lists filling out an unrelated questionnaire.

Results

The mean number of critical items recalled (out of 12) in each condition is displayed in the first row of Table 1. An analysis of variance (ANOVA) was performed using order (six levels; between-subjects) and cuing condition (congruent, incongruent, or no cues; within-subjects) as variables. The only significant effect, which was due to a complex pattern of performance between the six orders, was the interaction between order and cuing condition, $F(10, 82) = 2.51$, $MS_e = 1.97$, $p < .05$. Although the interaction does not lend itself to straightforward interpretation, one contributing factor is a slight tendency for performance to increase immediately following a trial involving either of the cued conditions. This tendency, which is least pronounced in the no-cue condition, cannot account for any of our major findings. The pattern of means reported in Table 1 was also observed when only those trials occurring in the first serial position were considered.

Significant part-list inhibition with incongruent cuing was indicated by contrasting recall in that condition to the mean for no-cue and congruent recall, $t(42) = 2.36$, $SE = 0.19$, $p < .05$; similarly, incongruent recall was significantly less than

Table 1
Mean Number of Critical Items Recalled in Experiments 1, 2, and 4 and Mean Proportion Recalled in Experiment 3 for Each Cue Condition

Experiment	Congruent		Incongruent		No cues	
	M	*SE*	*M*	*SE*	*M*	*SE*
Experiment 1 (Neutral words)	4.50	0.30	4.06	0.27	4.65	0.26
Experiment 2 (Famous names)	6.73	0.77	5.31	0.52	7.06	0.56
Experiment 3 (Famous names)	0.185	0.02	0.147	0.02	0.253	0.02
Experiment 4 (Idioms)	7.20	0.62	6.22	0.61	8.41	0.56

recall in the no-cue condition, $t(42) = 2.06$, $SE = 0.21$, $p < .05$. No significant difference was observed between the no-cue and congruent cue conditions, $t < 1$. Thus, significant inhibition was observed only when part-list cues were randomly chosen from the study list and not when the serial order of cues was congruent with the order in which list items were studied. However, the difference between incongruent and congruent recall proved only marginally significant, $t(42) = 1.73$, $SE = 0.19$; $p < .10$. This issue will be addressed in the General Discussion section.

Experiment 2

Experiment 1 showed that part-list inhibition is sensitive to the congruency between the serial order of part-list cues and of study items. In Experiment 2, we tested the validity of a broader concept of congruency by considering the meaning of the cues. Not only was the order of part-list cues changed in the incongruent condition, but it was done in such a manner as to change the cues' meaning. After studying a list of common first and last names, subjects were asked to either freely recall the names, to recall them in the presence of one name from each first–last name pair in order (congruent cues), or with the very same cues rearranged to make up a surprising list of famous names (incongruent cues). Because incongruent cues differ from the study list not only in order but also in meaning, we expected a large part-list inhibition effect. We also expected to replicate the absence of part-list inhibition in the congruent condition that we had observed in Experiment 1.

Method

Forty-seven Stanford University introductory psychology students participated in small groups for course credit. They heard a tape-recorded list of 36 common names (3 s per name), presented in the sequence first name, last name, first name, last name, and so on. After 60 s of mathematical problem solving (to disrupt short-term memory), one group was tested by free recall with no cues, and two others were given half the list as part-list cues. No-cue subjects were asked to write down as many names as they could from the previous list on a blank sheet of paper. In the cuing conditions, half of the names from the list were written single spaced down the left-hand column of a sheet of paper. Subjects were asked to first review the cues as a possible aid in the recall of other list items and then to write down any other names that they could (though they need not bother writing down the cues) in any order—first name, last name, or both—anywhere on the sheet. In the congruent cuing condition, the cues consisted of every first name from the first half of the list and every last name from the second half of the list in their original order. In the incongruent condition, the same cues were used but rearranged to comprise the names of famous people that had been camouflaged in the original list (see Table 2 for the materials). Each subject received a single list. Fifteen subjects were tested with congruent cues, and 16 each with incongruent cues and no cues. In all cases, subjects were given as much time to recall the list as they desired.

Results and Discussion

The mean number of noncue names recalled in each condition (out of 18) are presented along with standard errors in

Table 2
Study Materials and Cues Used in Experiment 2

	Group 1	Group 2
Study names	Congruent cues	Incongruent cues
Jackie Smith	Jackie	Jackie
Tom Johnson	Tom	Robinson
Steve Nelson	Steve	Tom
Robin Porter	Robin	Jones
Phil Henderson	Phil	Steve
George Freeman	George	Martin
Michael Schaeffer	Michael	Robin
Ben White	Ben	Williams
Jimmy Watson	Jimmy	Phil
Gordon Martin	Martin	Collins
Frank Collins	Collins	George
Peter Jackson	Jackson	Burns
Jeff Franklin	Franklin	Michael
Doug Robinson	Robinson	Jackson
Mark Carter	Carter	Ben
Tim Burns	Burns	Franklin
Tony Williams	Williams	Jimmy
David Jones	Jones	Carter

Note. A third group recalled the study list with no cues.

the second row of Table 1. Contrasts indicated a significant reduction in recall in the incongruent condition relative to the mean for no-cue and congruent-cue recall, $t(44) = 2.10$; $p < .05$, as predicted ($SE = 0.37$ for this and the following analyses). Incongruent performance was also significantly below that for no cues, $t(44) = 2.02$; $p < .05$. As in Experiment 1, no significant difference was observed between the congruent and no-cue means, $t < 1$. These data confirm the hypothesis that part-list inhibition arises when the arrangement of cues elicits a recall plan that is incongruent with the encoding of the study list. Significant inhibition was not observed when cues consisted of every second name from the study list; it was observed when the cues were identical elements but reordered to comprise a list of famous names. However, the difference between incongruent and congruent performance was not significant, $t(44) = 1.62$; *ns*, though in the predicted direction.

The design of Experiment 2 allowed further analysis of the cues influence on target recall. Because the study list comprised alternating first and last names, we can be reasonably certain that listeners segregated these as pairs and treated each pair as a unit naming a single person. Assuming this pairwise encoding, we can measure the extent to which subjects made use of the individual cues. Recall that the part-list cues included either the first name or the last name from each pair, and targets included the remaining name. To determine how cues were used during recall, all subjects (excluding one who defied classification) were classified according to one of two recall methods. Subjects either wrote the recalled names beside their corresponding cues on the recall sheet (the *beside* method) or as a list underneath the column of cues (the *underneath* method). Subjects who recalled using the beside method presumably tried to remember target names individually during recall, in association to specific cues. Subjects who recalled in the underneath fashion may have used each cue specifically, or they may have read the cues and then used other recall methods. The congruent-cue subjects were somewhat more likely to use the cues in the beside fashion (64%) than were the incongruent-cue subjects (38%), though this is not a significant difference. Subjects made less use of the cues in the incongruent condition, the condition which exhibited the most inhibition.

To help decide whether subjects who recalled in the underneath manner used the cues to guide their recall, the correspondence between the order of cues and the subject's recall order was inspected. To measure the correspondence in the orderings, a τ statistic was calculated for each subject. This statistic, which varies between -1 and 1, was used as a measure of the frequency with which the part-list cues and recall targets from two different first–last name pairs appeared in the same serial order in, respectively, the list of cues and in the subject's output list. All pairs for which the target was not recalled were excluded from the analysis. The median value of τ obtained from the 5 subjects who used the underneath method in the congruent condition was .71. The median from the 10 subjects provided incongruent cues was .24. This difference is significant by a Mann-Whitney median test adjusted for ties ($W = 63$; $p < .05$).

In sum, even after excluding subjects who wrote their responses directly beside cue items, of which there were more in the congruent condition, the consistency between the order of cues and of recalled items was substantially higher in the congruent than incongruent conditions. This result is not due to high correlations between recall order and the order of the original input list. This correlation was on average slightly negative in the incongruent condition and small but positive in the congruent condition. Subjects in the incongruent condition were evidently more likely to try to ignore the cues during recall. That they were not completely successful is suggested by the poor recall in that condition.

Experiment 3

Was the inhibition effect we observed with incongruent cues in Experiment 2 a result of having misled subjects? In that condition, part-list cues consisted of famous names, whereas the to-be-recalled target names did not. Perhaps some subjects inferred that the entire list was composed of rearranged famous names. They might then have searched only for list names that were famous and withheld recall of nonfamous names. Because none of the target names were famous, such a strategy would have produced very poor recall. This account is unsatisfactory for two reasons. First, no mention of famous names was made to subjects; the names simply appeared as cues, and subjects were encouraged to write down any name they could recall, including first names only or last names only. Second, every subject correctly recalled at least two target (nonfamous) names, contrary to this editing hypothesis. Nevertheless, in Experiment 3 we attempted to rule out this interpretation by replicating Experiment 2, using materials in which target (noncue) items also comprised famous names when rearranged. If the inhibition effect observed in Experiment 2 were due to recall being limited to famous names, no inhibition should be observed. However, if inhibition were due to the incongruency between study items and cues, the amount of inhibition here should be comparable to that of Experiment 2.

Method

The procedures of Experiment 3 were identical to those of Experiment 2, differing only in materials and subjects. The subjects were introductory psychology students at San Jose State University who were participating for course credit. Subjects were run in groups of 5 to 13. The 18 noncue items of Experiment 2 were replaced by the names of nine famous people (e.g., *Douglas MacArthur, Richard Burton, Sam Donaldson*). The new names were broken up at study by shuffling them among the original famous names by putting each new second name in the first half of the list (with an old first name) and each new first name in the second half (with an old second name). Twenty-six students were tested with no cues, 24 with congruent cues (every other name from the first half of the list and every other name from the second half of the list), and 23 were tested with incongruent cues (the same cues rearranged to make up famous names). In the congruent condition, half the subjects were given the part-list cues used in Experiment 2 (*Jackie, Tom, Steve*) and were asked to recall the remaining names (*MacArthur, Burton, Donaldson*), and half were given the new names as cues and were asked to recall the original set of names. In the incongruent condition, 12 subjects got the original cues (*Jackie Robinson, Tom Jones*), and 11 subjects

were shown the new famous names as cues (*Douglas MacArthur, Richard Burton*).

Results

Twice as many names were eligible for recall in the no-cue condition than the two cued conditions. Unlike previous experiments, in which the set of target items was constant, all names served sometimes as cues and sometimes as targets. We therefore used the proportion of eligible (noncue) names recalled as our dependent measure. The proportions for each cuing condition appear in Table 1. As indicated by contrasts, a large inhibition effect was observed in the incongruent condition relative to the mean of congruent and no-cue recall, $t(70) = 3.02$; $p < .01$, and relative to no-cue recall alone, $t(70) = 3.92$; $p < .001$ (*SE* of the contrasts was 0.20). Appreciable inhibition was observed, even though target items also comprised famous names. Targets were rarely recalled as famous name pairs. In the incongruent condition, only a single famous name was constructed from target items. Unlike our previous experiments, significant inhibition was also observed in the congruent condition, $t(70) = 2.55$; $p < .05$, although less than with incongruent cues. The difference between the congruent and incongruent means was again not significant, $t(70) = 1.37$; *ns* (*SE* of the contrasts was .20), although (again) in the predicted direction. Means were calculated separately for each of the two sublists of target names. Mean performance followed the same pattern as above on both sublists. Although the difference between the congruent and incongruent conditions was greater in Experiment 2 with Stanford University students (and more names were recalled) than in the current experiment with San Jose State University students, the ratio of names recalled in the two conditions did not differ.

Because of the low levels of recall in the congruent and incongruent conditions, the data were not sufficient to provide stable estimates of the relation between cue order and the order of recall.

Discussion

Using noncue target items that could be themselves rearranged to form famous names, we again observed a large part-list inhibition effect using famous names as cues. Again, we found no evidence that subjects tried to recall target items as famous name pairs. We thus can rule out the explanation that earlier results arose because the target items were not famous names like those suggested by the incongruent cues. Part-list inhibition was also observed using congruent cues in this experiment, but not quite as much as in the incongruent condition. Apparently, for San Jose State students, every second list name did not constitute a set of cues as congruent with their encoding of the study list as cues they could generate themselves when in the no-cues condition. Alternatively, San Jose State students may be more susceptible than Stanford University students to some other source of part-list inhibition, such as the disruption produced by editing part-list cues out of the recall protocol (Roediger & Tulving, 1974; cf. Nickerson, 1984, for other possibilities).

Experiment 4

The fourth experiment was a conceptual replication of Experiments 2 and 3 using different materials. The materials—two-word idioms—were composed of words that more closely resembled those used in the traditional part-list cuing paradigm.

Method

Subjects studied a list of common words and were then tested with either congruent, incongruent, or no cues. Two-word idioms were used instead of famous names as incongruent cues. The materials and cues appear in Table 3. As in Experiments 2 and 3, congruent cues consisted of essentially every second word from the list in the same order (the first, third, ... 17th, 20th, 22nd, ... 36th). Incongruent cues consisted of the identical words rearranged to form two-word idioms. The procedures were identical to those used in Experiments 2 and 3. The study list, identical for all subjects, was presented by tape recorder at a rate of 3 s per word; a 1-min retention interval was filled by mathematical problem-solving; and recall instructions, which emphasized writing down any word subjects could remember in any order on the sheet, were the same as previously. In both cue

Table 3
Study Materials and Cues Used in Experiment 4

	Group 1	Group 2
Study words	Congruent cues	Incongruent cues
sour plant	sour	sour
dead wet	dead	grapes
solid bright	solid	dead
cold dog	cold	end
green rich	green	solid
thin hot	thin	state
big true	big	cold
bad heavy	bad	turkey
flat house	flat	green
sky thumb	thumb	thumb
top end	end	thin
girl blood	blood	ice
wood grapes	grapes	big
sharp turkey	turkey	deal
paper broke	broke	bad
pencil ice	ice	blood
sweet deal	deal	flat
black state	state	broke

conditions, cues appeared as a single-spaced column of words down the left-hand side of the page. Subjects in the incongruent condition were not told explicitly that the cues comprised idioms.

The subjects were Stanford University students who had also participated in Experiment 2 and San Jose State University students who had participated in Experiment 3. All subjects were tested in one of the three conditions of the current experiment after participating in the corresponding condition of a famous-names experiment. Sixteen Stanford students were tested in each of the incongruent and no-cues conditions, and 15 were tested in the congruent condition. Twelve San Jose State students were tested with incongruent cues, 20 with no cues, and 24 with congruent cues.

Results

Because different numbers of subjects from the two schools participated in each condition, means were calculated and compared by giving equal weight to the contribution of each school in each condition. A two-way ANOVA was performed using school (San Jose State vs. Stanford) and cuing condition as factors. The main effect of school was significant, $F(1, 97) = 16.43$, $MS_e = 10.38$; $p = .0001$. Stanford subjects recalled an average of 2.6 more words than San Jose State subjects. Cuing condition also had a significant effect, $F(2, 97) = 3.64$; $p < .05$, which is analyzed further below. The interaction between the two was also significant, $F(2, 97) = 3.25$; $p < .05$, because of both more inhibition and less effect of congruency among San Jose State subjects than among Stanford subjects. A greater congruency effect with Stanford subjects was also observed comparing the results of Experiments 2 and 3.

The mean number of noncue items recalled (out of 18) and standard errors appear in Table 1. Contrasts indicated significant inhibition comparing incongruent recall to the mean of congruent and no-cue recall, $t(97) = 2.20$, $SE = 0.33$; $p < .05$, and comparing incongruent recall with no-cue recall alone, $t(97) = 2.67$; $p < .01$. The difference between the congruent and no-cue conditions was not significant, $t(97) = 1.59$; *ns*. As in Experiments 1 and 2, a larger part-list inhibition effect was observed using incongruent cues than was produced by cues selected to be congruent with the original study list. However, the difference between incongruent and congruent recall again failed to reach statistical significance, $t(97) = 1.21$; *ns*.

General Discussion

In four experiments, we found that the magnitude of part-list inhibition depended on the relation between cue and target items. We consistently found more inhibition when the serial order of cues differed from their order at study than when their order remained the same, even though targets and cues were nominally identical. In Experiment 1, cues consisted of every second word from the study list in the congruent condition but were randomly selected in the incongruent condition. Significant inhibition relative to uncued recall was observed in the incongruent condition, but not in the congruent condition. The lack of significant inhibition in the congruent condition suggests that subjects encoded information related to serial position during study and used this information during recall to help cue retrieval. In Experiments 2–4, congruent cues were again (essentially) every second word from a study list. Incongruent cues were also every second studied word but reordered on the cue sheet to comprise famous names (Experiments 2 and 3) or familiar idioms (Experiment 4). In all experiments, more inhibition was observed with incongruent cues than with congruent cues. Using a meta-analytic technique (Mullen, 1989) to combine the results of our four experiments and thereby achieve more power, the difference between incongruent and no-cue recall proved highly significant, $z = 5.15$; $p < .0001$, as did the difference between incongruent and congruent recall, $z = 2.92$; $p < .01$.[1] In the remainder of this discussion, we will briefly expand on our results, point out their relation to some earlier studies of part-list cuing, and end with a discussion of the cognitive mechanisms that might underlie our congruency effects.

In only one of four experiments was a significant amount of inhibition obtained in the congruent condition. Nevertheless, congruent performance was below that of no-cue performance in all four cases. Combining over experiments, the difference proved significant, $z = 2.44$; $p < .05$. As discussed earlier, inhibition in the congruent condition could represent a failure on our part to achieve sufficient congruency between cues and list items to bring performance up to the level of the no-cue condition, or factors other than congruency could be implicated. In any case, as noted above, congruent performance was significantly above that of recall in the incongruent conditions. Furthermore, the size of the inhibition effect, as determined by combining over the four experiments (Mullen, 1989), is clearly greater with incongruent cues relative to no cues, $r = 0.75$, than with congruent cues, $r = 0.60$.

In Experiment 2, we also found that subjects made more use of the cues in the congruent than in the incongruent condition. This is consistent with the claim that incongruent cues inhibit performance even when they are not used overtly to guide recall. The data imply either that only incongruent cues enlisted a retrieval framework not conducive to recall or that both kinds of cues disrupted retrieval but, in the congruent case, this disruption was partly offset by a process in which cues helped recall. Either way, the data are consistent with our congruency principle and provide another illustration of the encoding specificity principle (Thomson & Tulving, 1970). They are also consistent with the transfer-appropriate procedures approach described by Roediger (1990). Recall was poor when cues suggested an organization incongruent with the way in which list items had been organized during study.

We considered the possibility that the large inhibition effects in the incongruent conditions of Experiments 2–4 came about by tricking subjects. Perhaps the new meanings of the incongruent cues simply confused subjects by suggesting a feature that the target items did not include, and this disrupted their reconstruction of the original lists. (This argument does not apply to Experiment 1.) Doubt is cast upon this possibility by the finding of large inhibition effects when the to-be-

[1] These z scores were computed using unweighted sums over the separate experiments. The values remained substantially unaffected by weighting the contribution of each experiment by its sample size.

remembered targets were, like the cues, also famous names (Experiment 3). So the cause of poor recall was not that subjects were induced to believe a feature to be present in the targets when in fact it was absent. More important than the results of Experiment 3, in Experiments 2–4, subjects were themselves aware that neither famous names nor idioms had appeared on the study list (as they testified during debriefings). Despite their awareness and despite being encouraged to recall all the names that they could, their performance was inhibited.

Relation to Previous Work

Our Experiment 1 is similar to two experiments reported by Slamecka (1969), except that he showed subjects the same list of words in the same order three times. After each of the first two presentations, subjects were tested by free recall with no cues. The congruency manipulation was performed after the third presentation. The pattern of results of his first experiment was identical to that of our Experiment 1: inhibition in the incongruent but not the congruent condition. In his Experiment 2, Slamecka warned his subjects, "30 words would be presented in a fixed order," and the nature of all recall tests was described. This time, inhibition was observed with both kinds of cues. We suggest that subjects' knowledge that the same list would be presented three times encouraged them to encode it using their own idiosyncratic strategies, thus increasing subjective organization and eliminating any advantage provided by the serial order of the part-list cues. This is also consistent with the higher rates of recall Slamecka obtained in Experiment 2 relative to Experiment 1.

The idea that part-list inhibition is the consequence of the elicitation of retrieval sets that do not match the structure of the list-as-encoded may help explain inhibition effects found in experiments using materials of a type different from our own. Inhibition with extralist cues (Roediger et al., 1977), for example, could also result from an incongruency between cues and the encoded list. Unless extralist items are carefully chosen, they necessarily bear little relation to list items and are therefore likely to be incongruent.

Is there a role for incongruency in categorized-list experiments, in which the presence of some category instances inhibits the recall of others (Mueller & Watkins, 1977; Roediger, 1973; Rundus, 1973; Slamecka, 1968; Sloman, 1991)? Incongruency could play a role if the interpretations subjects give to category labels are not fixed, but sensitive to the context in which the labels are presented. In particular, the interpretation of a category label could be influenced by the presence of category instances that could, for example, make certain attributes of category members more or less salient. If so, the interpretation of a category when presented with a set of instances for study may be different from the interpretation of the same nominal category when presented with a subset of those instances as cues. To the extent that the cues change the meaning of the category and thereby exclude from its set of subordinates presented instances that subjects would otherwise recall, part-list inhibition will obtain. If this speculation is correct, then the extent of part-list inhibition in a category will be negatively correlated with the degree of consensus concerning the set of instances that comprise that category.

An experiment by Mueller and Watkins (1977) helps elucidate the boundary conditions of the congruency principle. In their Experiment 1, subjects were shown categorized lists and later tested with category name cues alone, with category names along with instances of that category (related cues), or with category names along with list items that were instances of a different category (unrelated cues). Relative to the category-name-alone condition, inhibition was observed in the related-cue condition but not in the unrelated-cue condition. Apparently, subjects were able to ignore the unrelated category instances during recall. Presumably, this was possible because the cues bore no relation to the instances that subjects were trying to recall. Because common categories were used, this fact would have been obvious to subjects. Cues and targets were semantically unrelated, and because subjects were always presented words that were blocked by category, they knew that the words had not been associated during the experiment. In sum, when cues and targets are very different from each other and when people are aware of this difference, incongruent cues may not interfere with recall.

Conclusion

None of the theoretical accounts of part-list cuing inhibition previously proposed seem able to handle the differences that we have observed between congruent and incongruent cuing. Our congruent and incongruent cues were always identical items but simply shown in different orders, the orders sometimes suggesting different meanings. Explanations of our results must therefore consider how serial order affects the meanings of the cues. These relations are not considered by the editing task hypothesis (Roediger & Tulving, 1974), the increased-list-length hypothesis (Watkins, 1975), the cue-overload hypothesis (Mueller & Watkins, 1977), or the interference-with-maintenance hypothesis (Nickerson, 1984).

As discussed earlier, Rundus's (1973) model implies the kind of order independence of recall cues that our observed differences refute. To incorporate our results, Rundus's theory would have to assume a different representation scheme that can take into account serial order and new semantic relations. Other computational models that have been used to model part-list inhibition (Metcalfe & Murdock, 1981; Raaijmakers & Shiffrin, 1981) encounter the same difficulty as Rundus's model. As currently formulated, they do not capture the fact that the order of words can determine their meaning and their representation in memory.

The problem with Rundus's model is its reliance on item-specific response competition. Our experiments have shown that such a notion is not sufficient to describe part-list inhibition. A more general construct is necessary because relations among cues can affect target recall. This point is analogous to one made by Postman and Underwood (1973) in a discussion of problems with interference theory. They argued that discrepancies between data and theory suggested the hypothesis of general response-set interference (see Postman, Stark, & Fraser, 1968). "According to this hypothesis, unlearning results from the operation of a mechanism of response selection which exerts its primary effect on the entire class of first-list responses rather than on specific stimulus–response associa-

tions" (Postman & Underwood, 1973, p. 22). The central idea is that of a selector mechanism that activates or suppresses sets of responses and that is "characterized by a certain amount of inertia." Postman and Underwood were vague about the size of the sets of responses that are selected or inhibited. Single lists of words are sometimes the unit that is selected, but Postman and Underwood left open the possibility that sublists unified by category or by experimental context could also be differentially selected and inhibited. We suggest that part-list cues that suggest response sets incompatible with the encoding of items may inhibit recall. The critical aspect of the situation to consider is the relation between the cues and the target material.

We have proposed that part-list inhibition is an instance of the difficulty that people have remembering one thing when attending to another unless the two were encoded together. This view shares an additional assumption with response-set interference: the notion of persistence, or what Postman and Underwood refer to as *inertia*. One reason that part-list inhibition is surprising is that it would not occur if subjects simply ignored the part-list cues or at least followed up their use by employing whatever cues they would otherwise have used in free recall. The presence of inhibition indicates that, sometimes, subjects do not, and possibly cannot, ignore the cues. Subjects seem to get stuck in a kind of local minimum. Even when cues are obviously misleading, such as in the incongruent conditions of our Experiments 2–4, attention to the cues persists long enough to adversely affect performance.

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