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*Psychon Bull Rev*. Author manuscript; available in PMC 2010 August 4.

Published in final edited form as:
*Psychon Bull Rev*. 2008 April ; 15(2): 296–301.

# Part-list Cuing and the Dynamics of False Recall

**Daniel R. Kimball**,
University of Texas at Arlington

**Elizabeth L. Bjork**,
University of California, Los Angeles

**Robert A. Bjork**, and
University of California, Los Angeles

**Troy A. Smith**
University of Texas at Arlington

## Abstract

False recall of an unpresented critical word after studying its semantic associates can be reduced substantially if the strongest and earliest-studied associates are presented as part-list cues during testing (Kimball & Bjork, 2002). To disentangle episodic and semantic contributions to this decline in false recall, we factorially manipulated the cues' serial position and their strength of association to the critical word. Presenting cues comprising words that had been studied early in a list produced a greater reduction in false recall than did presenting words studied late in the list, independent of the cues' associative strength—but only when recall of the cues themselves was prohibited. When recall of the cues was permitted, neither early-studied nor late-studied cues decreased false recall reliably relative to uncued lists. The findings suggest that critical words and early-studied words share a similar fate during recall—owing to selective episodic strengthening of their associations during study.

### Keywords

false memory; part-list cuing; retrieval inhibition; semantic; episodic

In the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995), participants study a list of words (e.g., *mad*, *fear*, *hate*, etc.) that are strong semantic associates of an unpresented critical word (e.g., *anger*), then falsely recall and recognize the critical word at rates often approaching veridical recall rates (for a review, see Gallo, 2006). Researchers have recently explored how such false memory is affected by manipulations known to cause forgetting, including directed forgetting (e.g., Kimball & Bjork, 2002), retrieval-induced forgetting (Bauml & Kuhbandner, 2003), and delay-based forgetting (for a review, see Thapar & McDermott, 2001).

The current research concerns forgetting of DRM lists induced by part-list cuing, which involves re-presentation of some studied words during testing, ostensibly to aid retrieval. Such part-list cues actually impair veridical recall relative to recall without such cues (e.g., Rundus, 1973; for a review, see Nickerson, 1984). With DRM lists, part-list cues have reduced not just veridical recall, but also critical-word intrusions (Bauml & Kuhbandner,

Corresponding Author: Daniel R. Kimball, Department of Psychology, Box 19528, University of Texas at Arlington, Arlington, TX 76019, Phone: 817-272-5480, dkimball@uta.edu.

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2003; Kimball & Bjork, 2002; Reysen & Nairne, 2002). One reason this finding is important is that veridical and false recall tend to be negatively correlated (Roediger, Watson, McDermott, & Gallo, 2001; but see Kimball, Smith, & Kahana, 2007) and are affected differently by many other manipulations (e.g., directed forgetting, Kimball & Bjork, 2002; delay-based forgetting, Thapar & McDermott, 2001; see Gallo, 2006, for a review).

In the present study, we examined the effects on veridical and false recall of three variables related to part-list cues: the serial position of the cues, the strength of their semantic association to the critical word, and the permissibility of recalling the cues. To examine the effects of cue serial position and cue associative strength separately, we sought to avoid confounding the serial positions and associative strengths of list words. In their influential paper, Roediger and McDermott (1995) presented DRM list words in descending order of forward associative strength, defined as the probability of producing a list word in response to the critical word in a word association task. Adopting this procedure, Kimball and Bjork (2002) presented part-list cues that were the strongest four, the strongest eight, the weakest four, or the weakest eight forward associates of the critical word. However, because the list words were always presented in descending order of forward associative strength, those cues were also the earlieststudied four or eight words, or the latest-studied four or eight words, respectively.

Kimball and Bjork (2002) found typical cuing-induced impairment of veridical recall relative to uncued lists, and the impairment increased as the number of part-list cues increased, consistent with previous research (e.g., Rundus, 1973). Critical-word intrusions also declined as cue number increased. Importantly for present purposes, cue associative strength and/or cue serial position also affected false recall: Participants intruded fewer critical words when part-list cues were earlier-studied, stronger associates of the critical word than when they were later-studied, weaker associates.

Kimball and Bjork (2002) interpreted their results using Rundus's (1973) retrieval competition theory. This theory assumes that retrieval is guided by cues induced during study, such as category names for a list comprising exemplars from multiple categories. Retrieval access is determined probabilistically by strength-dependent competition, first among all retrieval cues, and then among all words associated to an accessed retrieval cue. The strength of association between a word and its retrieval cue increases each time the word is accessed, making repeated retrievals increasingly likely. Each such repeated retrieval constitutes a failure to retrieve a new item, and search using a particular retrieval cue stops—and search finally stops altogether—when successive retrieval failures reach criterion. When part-list cues are presented, they become hyper-accessible like retrieved items, gaining a competitive retrieval advantage over non-cues. This advantage increases as cue number increases, yielding increasing impairment of non-cue recall.

Kimball and Bjork (2002) also assumed that the critical word—by virtue of its relationship to the retrieval cues induced during study—is subject to the same retrieval competition dynamics as are studied items. Thus, critical-word intrusions should decline as cue number increases, as Kimball and Bjork observed. They assumed further that the critical word is more likely to share retrieval cues with its stronger semantic associates than with its weaker associates, a consequence of which is that when those stronger associates become hyper-accessible as part-list cues, the critical word is competitively disadvantaged during retrieval.

The foregoing interpretation focuses on differences in cue associative strength, rather than cue serial position, to explain the false-recall pattern observed by Kimball and Bjork (2002), and emphasizes semantic influences operating at retrieval rather than encoding. Should it be the case, however, that the observed false-recall pattern is instead attributable to cue serial

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position, rather than cue associative strength, the pattern would be better explained by semantic influences operating at encoding rather than retrieval. For a retrieval competition interpretation to remain viable, such a finding would suggest that the critical word and the early-studied list items would share retrieval cues, as might occur, for example, if the critical word emerges into conscious awareness and is intruded into rehearsal early in the study phase (e.g., Goodwin, Meissner & Ericsson, 2001). Such a finding would also directly contradict a straightforward spreading activation account, as advocated by Roediger et al. (2001), which would predict similar activation of the critical word at study regardless of cue serial position and greater activation of the critical word at test with stronger rather than weaker associates serving as cues. We sought to distinguish between these explanations by un-confounding the effects of cue serial position and cue associative strength.

Our third independent variable, cue recall permissibility, was also motivated by predictions of the retrieval competition theory. According to the theory, when recall of part-list cues is prohibited, every retrieval of a part-list cue is counted as a failure to retrieve a new item, increasing the speed with which a participant abandons the retrieval cues associated with part-list cues. By contrast, when recall of part-list cues is permitted, the initial retrieval of a part-list cue is not a failure to retrieve a new item and participants would consequently search longer using the retrieval cues associated with the part-list cues. We reasoned that, when the critical word and the part-list cues share retrieval cues, critical-word intrusions should increase as participants extend their search using those retrieval cues.

## EXPERIMENT 1

### Method

**Participants—**Participants were 96 undergraduates at the University of California, Los Angeles, participating for course credits or as a class exercise, in groups of up to 14. Five other participants were replaced due to equipment malfunction or failure to follow instructions.

**Design—**We factorially manipulated three variables within subjects: (a) *cue serial position* (either the eight earliest or eight latest studied words); (b) *cue associative strength* (either the eight strongest or eight weakest studied semantic associates of the critical word); and (c) *cue recall permissibility* (cues remained present during the test and their recall was prohibited, or they were removed and their recall was permitted). In Experiment 1, we operationally defined cue associative strength as forward association strength (FAS), using the ranking in Roediger and McDermott (1995) and Kimball and Bjork (2002). For the strongest and weakest eight forward associates, mean FAS were .08 and .01, respectively, using values reported in Roediger et al. (2001).

**Materials and Apparatus—**Twelve lists, each comprising 15 words, were presented via audiotape in the following (randomly determined) order, as defined by the critical words: *smell*, *smoke*, *soft*, *slow*, *anger*, *needle*, *rough*, *window*, *sleep*, *cold*, *chair*, and *sweet* (for the lists, see Roediger et al., 2001). To permit factorial manipulation of cue associative strength and cue serial position, and to maximize differences in the levels of those variables across conditions, six lists were presented in descending order of forward associative strength and six in ascending order.

The testing booklet contained five pages for each list: a filler page viewed during study; math problems for the distractor task; the cue sheet; a filler page; and the recall sheet. For each list, the cue sheet contained either eight rows of pound signs (uncued condition), or a random ordering of the eight strongest or weakest critical-word associates (strong-cue and weak-cue conditions, respectively). The list's study order determined whether such cue sets

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comprised words studied earliest (early-cue condition) or latest (late-cue condition). Each recall sheet either re-presented the cues with an instruction to recall only the remaining list words (cue-recall-prohibited condition) or presented only an instruction to recall all list words (cue-recall-permitted and uncued conditions).

One list was assigned to each of the eight combinations of cue associative strength, cue serial position, and cue recall permissibility. Two lists in each study order were assigned to the uncued condition to provide appropriate baselines. Conditions were block-randomized to insure distribution across the list sequence, and assignment of lists to conditions was counterbalanced across two audiotape and six booklet versions.

**Procedure—**After instructions, participants were cued by audiotape to perform four tasks for each list: listen to the list, presented at a 1.5s/word rate; solve math problems for 30s; view the cue sheet for 15s; and recall the list for 90s. Participants were asked to use the cues to think of other list words, to recall words only if confident they were on that list, and to spend the entire 90s attempting recall.

## Results

Figure 1 shows that recall of part-list cues, when permitted, was higher ($M = 66$, $SE = 1$) than for the same words in the uncued condition ($M = 50$, $SE = 1$), $F(1,95) = 163.75$, $MSE = 579.37$, $p < .0001$, and the magnitude of this increment was unaffected by cue associative strength or cue serial position, *F*s < 1.53, *p*s > .22. Cuing thus increased cue accessibility as intended.

Figure 2 depicts mean recall of non-cue studied items. A within-subjects ANOVA revealed that veridical recall was lower for cued lists ($M = 43$, $SE = 1$) than for uncued lists ($M = 50$, $SE = 1$), $F(1,95) = 57.47$, $MSE = 252.79$, $p < .0001$, and the magnitude of this impairment was unaffected by cue associative strength, $F < 1$, cue serial position, $F < 1$, cue recall permissibility, $F(1,95) = 2.29$, $MSE = 475.07$, $p > .10$, or some interaction of these variables, *F*s < 1.

Figure 3 shows the pattern of critical-word intrusion rates. Critical-word intrusions in the uncued baseline condition did not differ across study orders (*M*s = 59, *SE*s = 4), $F < 1$. Consistent with previous research, the overall critical-word intrusion rate was lower for cued lists ($M = 49$, $SE = 3$) than for uncued lists, $F(1,95) = 11.97$, $MSE = 1428.04$, $p = .0008$. However, critical-word intrusions declined reliably below the uncued baseline in only two individual conditions, both of which involved prohibiting recall of early-studied cues, whether they were strong cues ($M = 33$, $SE = 5$), $F(1, 95) = 25.26$, $MSE = 2577.85$, $p < .0001$, or weak cues ($M = 43$, $SE = 5$), $F(1, 95) = 7.60$, $MSE = 3508.77$, $p = .0070$. Critical-word intrusions in these two conditions did not differ reliably, $F(1, 95) = 1.49$, $MSE = 2824.01$, $p > .20$. All other reliable effects reported below are due to differences between these two conditions combined versus other relevant conditions.

When cue recall was prohibited, there were fewer intrusions when cues were early-studied items ($M = 38$, $SE = 4$) rather than late-studied items ($M = 51$, $SE = 4$), $F(1, 95) = 7.88$, $MSE = 2065.52$, $p = .0061$. Intrusion rates, however, did not differ reliably between the strong-cue condition ($M = 42$, $SE = 4$) and the weak-cue condition ($M = 47$, $SE = 4$), $F(1, 95) = 1.18$, $MSE = 1793.59$, $p > .25$, nor did cue associative strength interact with cue serial position, $F < 1$. These data suggest that the substantial decline in critical-word intrusions observed by Kimball and Bjork (2002) was attributable to the cues' early serial position rather than their strong semantic association to the critical word, contrary to Kimball and Bjork’s interpretation. Notably, we replicated Kimball and Bjork’s pattern of results across comparable conditions.

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When cue recall was permitted, however, critical-word intrusions were not reliably affected by cue serial position, cue associative strength, or their interaction, *F*s < 1. Consequently, cue recall permissibility interacted reliably with cue serial position, $F(1, 95) = 4.21$, $MSE = 2255.35$, $p = .0430$, such that early-studied cues reduced critical-word intrusions reliably when their recall was prohibited rather than permitted, $F(1, 95) = 10.28$, $MSE = 2279.61$, $p = .0018$, whereas for late-studied cues, cue recall permissibility had no reliable effect, $F < 1$. Cue associative strength had no reliable main or simple effects on critical-word intrusions, nor did it interact with the other two variables, *F*s < 1.53, *p*s > .22.

### Discussion

Part-list cuing substantially reduced critical-word intrusions only when cues were early-studied items and their recall was prohibited. The strength of the cues' semantic association to the critical word had no effect on such intrusions. This pattern supports predictions of the retrieval competition theory premised upon the episodic association of the critical word to the same retrieval cues as early-studied words: When those words become hyper-accessible as part-list cues, the critical word suffers from increased retrieval competition, but this competition can be mitigated if search using the shared retrieval cues is prolonged by permitting rather than prohibiting cue recall.

Importantly, the absence of an effect of our variables (other than cuing alone) on veridical recall rules out explanations that predict differences in both false and veridical recall. The retrieval competition theory, however, predicts a competitive disadvantage for non-cues regardless of whether they are strong or weak critical-word associates, or early-studied or late-studied words. In addition, permitting rather than prohibiting cue recall renders initial part-list cue retrievals overt rather than covert, but does not affect overall accessibility of the cues and thus does not affect the competitive disadvantage of non-cues.

The absence of an effect of cue recall permissibility on veridical recall is consistent with the finding by Oswald, Serra, and Krishna (2006) of typical levels of non-cue impairment when pre-exposed cues were removed and their recall permitted. Roediger, Stellon, and Tulving (1977) also found that permitting versus prohibiting cue recall produced similar degrees of non-cue impairment during an initial 90s of recall. Bauml and Aslan (2004) have also provided support for treating our variable as a manipulation of cue recall permissibility rather than cue presence during testing, in that they found typical cuing-induced impairment when pre-exposed cues were absent during testing of non-cue recall, suggesting that such impairment is not attributable to cue presence or absence per se.

## EXPERIMENT 2

Our finding that cue associative strength had no reliable effect on critical-word intrusions is susceptible to an argument that the strong and weak cues may not have differed sufficiently in mean backward association strength (BAS)—the probability of producing the critical word in response to list words during a word association task—especially given the greater importance of BAS than FAS in producing critical-word intrusions (Roediger et al., 2001). In Experiment 1, mean BAS for the eight strongest and weakest *forward* associates were .25 and .20, respectively, using values reported in Roediger et al. In Experiment 2, we used the same lists as in Experiment 1, but redefined cue associative strength as BAS rather than FAS. Mean BAS for the eight strongest and weakest *backward* associates in our lists were .38 and .07, respectively—a six-fold increase over the BAS disparity between cue sets in Experiment 1. As a further test of cue associative strength, and as an additional parallel to Kimball and Bjork (2002), we included conditions using only the four strongest and weakest backward associates, with mean BAS of .50 and .03, respectively. We randomized the study

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order of words within lists to control for cue serial position effects, and prohibited cue recall in all conditions to maximize cuing effects.

### Method

Participants were 114 undergraduate students at the University of Texas at Arlington, participating for course credits; one participant was excluded for failure to follow instructions. The method was the same as in Experiment 1, except as follows: A computer controlled stimulus presentation and recorded responses; study order of lists and of words within lists was completely randomized anew for each participant; cue recall was always prohibited; and strong and weak cues were defined by BAS. There were four uncued lists, and two lists for each of the four combinations of cue number and cue associative strength.

### Results and Discussion

As Figure 4 shows, veridical recall was lower overall with part-list cues than without them, $F(1, 112) = 21.82$, $MSE = 76.77$, $p < .0001$, and the impairment was greater with eight cues than with four cues, $F(1, 112) = 12.63$, $MSE = 136.08$, $p = .0006$, as in Kimball and Bjork (2002). Cue associative strength produced no reliable main or simple effects and did not interact with cue number, *F*s < 1.

Figure 5 shows that critical-word intrusions exhibited a similar pattern, with fewer intrusions overall with part-list cues than without them, $F(1, 112) = 8.65$, $MSE = 414.43$, $p = .0040$, and fewer intrusions with eight cues than with four cues, $F(1, 112) = 9.28$, $MSE = 1051.28$, $p = .0029$, as in Kimball and Bjork (2002). Again, however, cue associative strength produced no reliable main or simple effects and did not interact with cue number, *F*s < 1.53, *p*s > .22. Thus, notwithstanding the much greater disparities in BAS between strong-cue and weak-cue sets, the results echoed the absence in Experiment 1 of any effect of cue associative strength on critical-word intrusions.

## GENERAL DISCUSSION

Our findings—that presenting part-list cues substantially reduced false recall only when cues were early-studied words and their recall was prohibited, and that cue associative strength did not influence false recall—suggest that the critical word becomes associated episodically with early-studied words and then shares a common fate with those words at retrieval: When those words serve as part-list cues, false recall declines substantially if cue recall is prohibited, but not if it is permitted.

The results, in our view, support a version of the retrieval-competition theory in which the critical word and early-studied words share retrieval cues induced during study and, consequently, compete most directly for retrieval access. The critical word is disadvantaged most at retrieval when early-studied words become stronger competitors due to their re-presentation as part-list cues. When recall of early-studied cue words is permitted and search using the shared retrieval cues is consequently extended, there is greater opportunity to access the critical word, mitigating the effects of retrieval competition.

The lack of a reliable effect of cue associative strength on false recall was surprising, especially given the large disparity in BAS between strong-cue and weak-cue sets in Experiment 2. This result—much like the basic part-list-cuing effect itself—is hard to square with accounts based on spreading semantic activation and cue-dependent retrieval. In particular, the insignificance of associative strength in modulating the effect of part-list cues on false recall contradicts predictions of the activation-monitoring account. The result also contradicts Kimball and Bjork’s (2002) assumption that the critical word is most likely to share retrieval cues with its strongest semantic associates. It is possible, however, that the

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critical word may be semantically related equally well to the retrieval cue induced for any subset of the list words, given that the critical word is likely to be among the few words—perhaps the only word—jointly associated to all words in such a subset (for a similar argument, see Kimball et al., 2007). Thus, it is likely that such a jointly associated retrieval cue would be induced early during encoding, after study of only a few words, facilitating the early emergence of the critical word into consciousness and its episodic association with the early-studied words.

The induction of retrieval cues at study followed by competition at retrieval could play the role otherwise played by spreading activation in a general account of false recall that continues to include monitoring processes, with such monitoring processes used to evaluate candidates accessed via retrieval cues rather than via spreading activation. However, such monitoring processes alone cannot plausibly explain our results because the efficacy or inefficacy of such processes cannot easily account for our co-occurring declines in veridical and false recall. For example, Reysen and Nairne (2002) suggested that part-list cues reinstate the study context, facilitating source monitoring and rejection of the critical word, but this account would counterfactually predict cuing-induced facilitation of veridical recall.

Similarly, Brainerd and Reyna (2005, pp. 141-142), applying fuzzy trace theory, argued that part-list cues heighten access to the verbatim trace associated with studied words—more so when the cues are stronger critical-word associates, due to their purportedly greater familiarity—thereby impeding access to the semantically based gist trace associated with the critical word. However, this account would also seem to predict cuing-induced facilitation of veridical recall, and our results do not support the claimed effect of using stronger associates as cues. A modified fuzzy-trace account positing greater access to the verbatim trace with early-list cues rather than late-list cues might explain the substantial decline in false recall with early-list cues, but it would not explain the elimination of that decline when cue recall is permitted nor the lack of increased veridical recall with increased access to the verbatim trace.

As this discussion makes clear, the unintuitive effects of part-list-cuing present challenges to explanations of both veridical and false recall. Our results provide evidence of interacting episodic and semantic influences in the processes underlying false recall, processes that span encoding and retrieval phases. These dynamics comport with predictions of the retrieval competition theory and, more generally, provide important constraints on all theories of false memory and part-list cuing.

## Acknowledgments

This research was supported by National Institutes of Health research grant MH079357 and training grant NS07292. We thank Keith Holyoak, Barbara Knowlton, Shi Zhang, and Michael Kahana for comments on earlier drafts.

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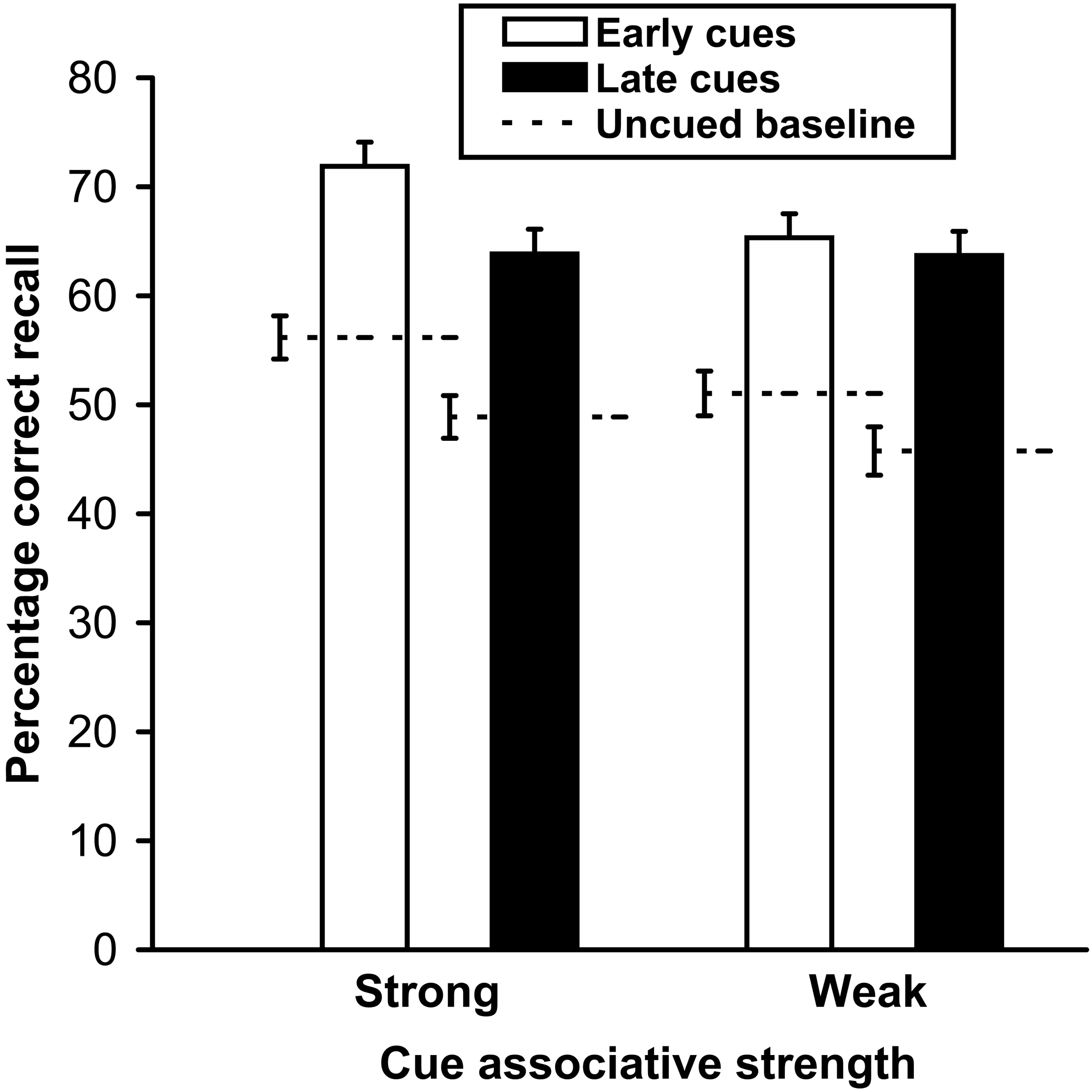


**Figure 1.**
Mean percentage correct recall (and standard errors) for words used as part-list cues in the cue-recall-permitted condition and for the same words in the uncued condition, as a function of cue serial position and cue associative strength in Experiment 1.

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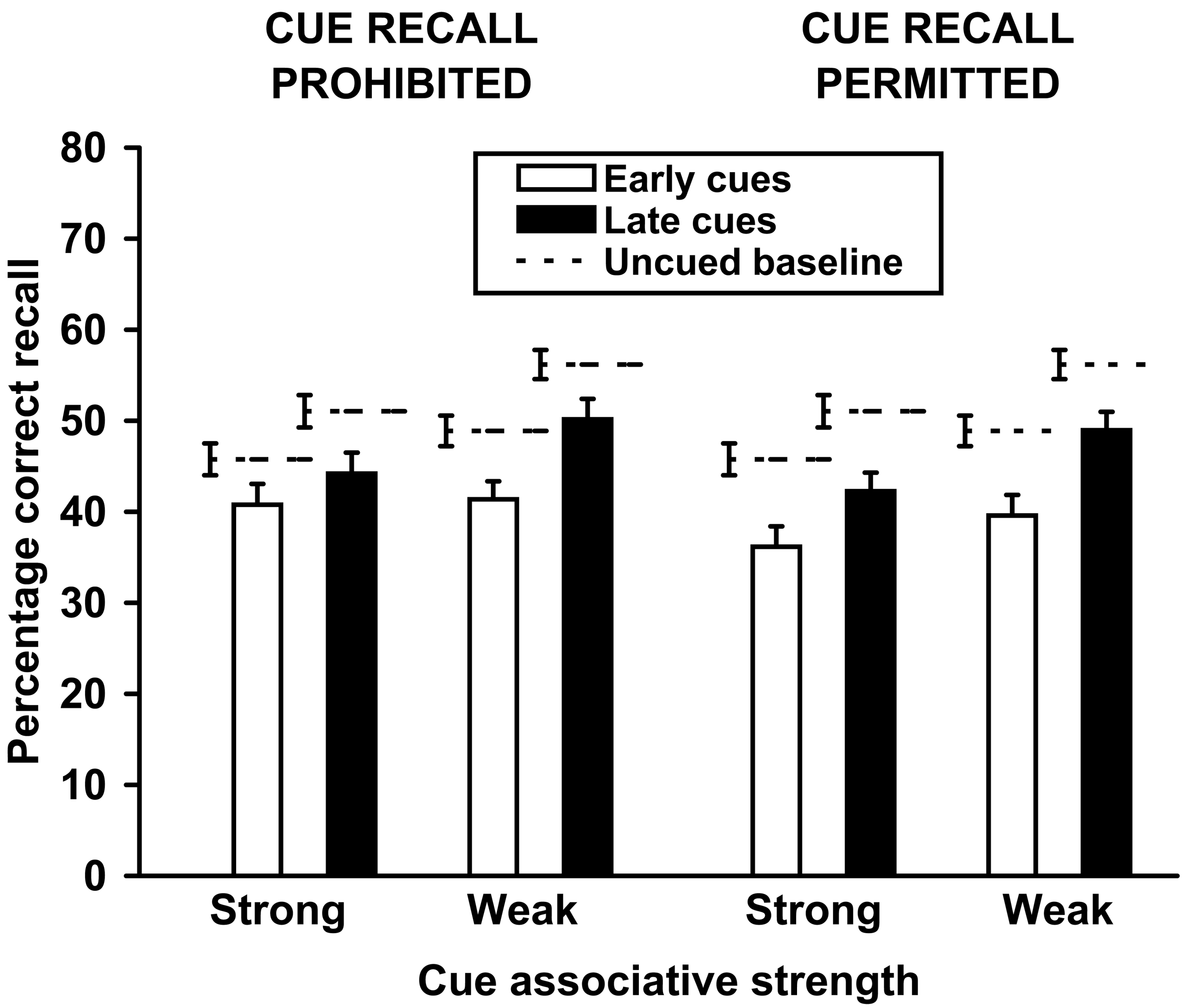


**Figure 2.**
Mean percentage correct recall (and standard errors) for non-cue studied items in the uncued and cued conditions, as a function of cue serial position, cue associative strength, and cue recall permissibility in Experiment 1.

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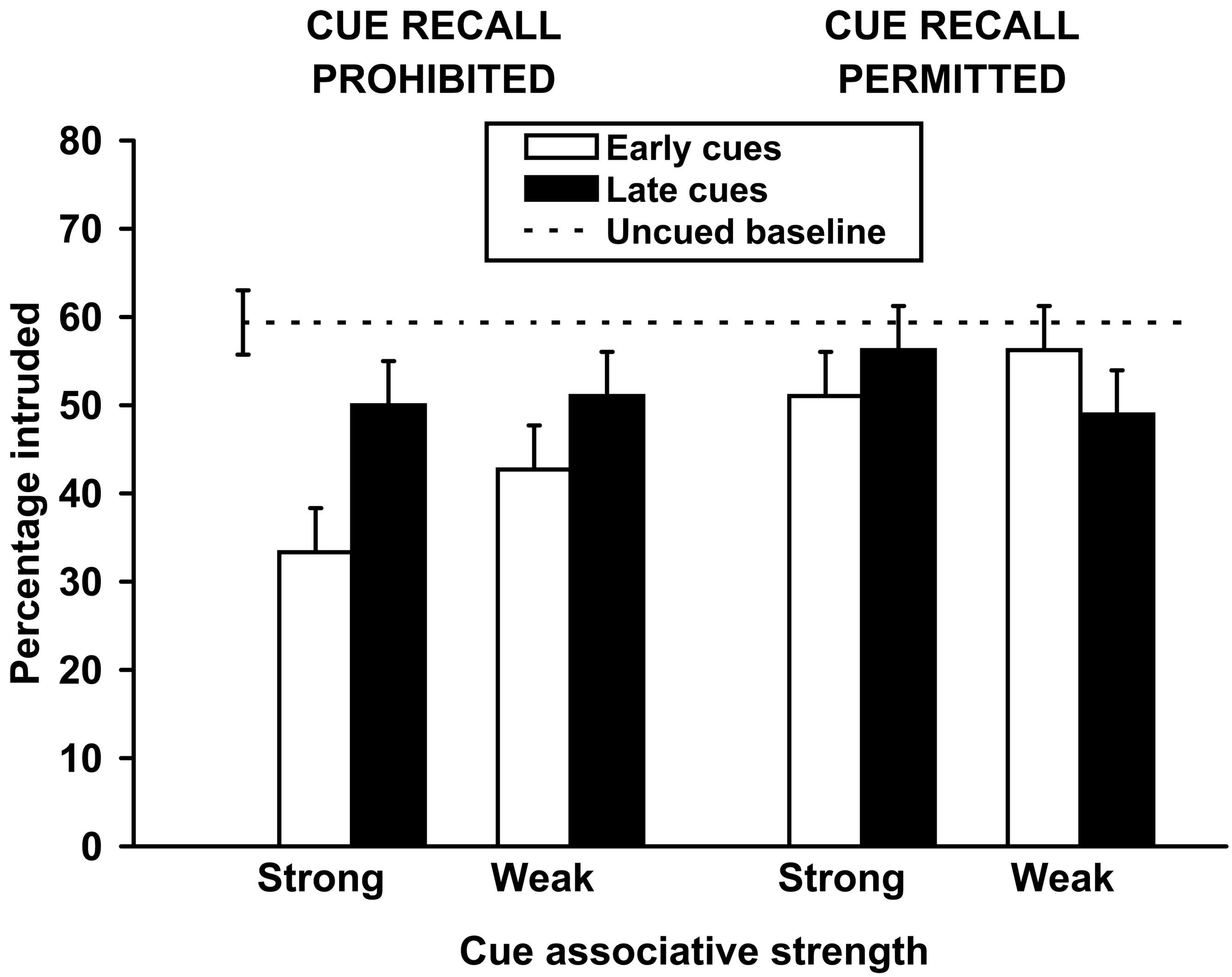


**Figure 3.**
Mean percentage of critical words intruded (and standard errors) in the uncued and cued conditions, as a function of cue serial position, cue associative strength, and cue recall permissibility in Experiment 1.

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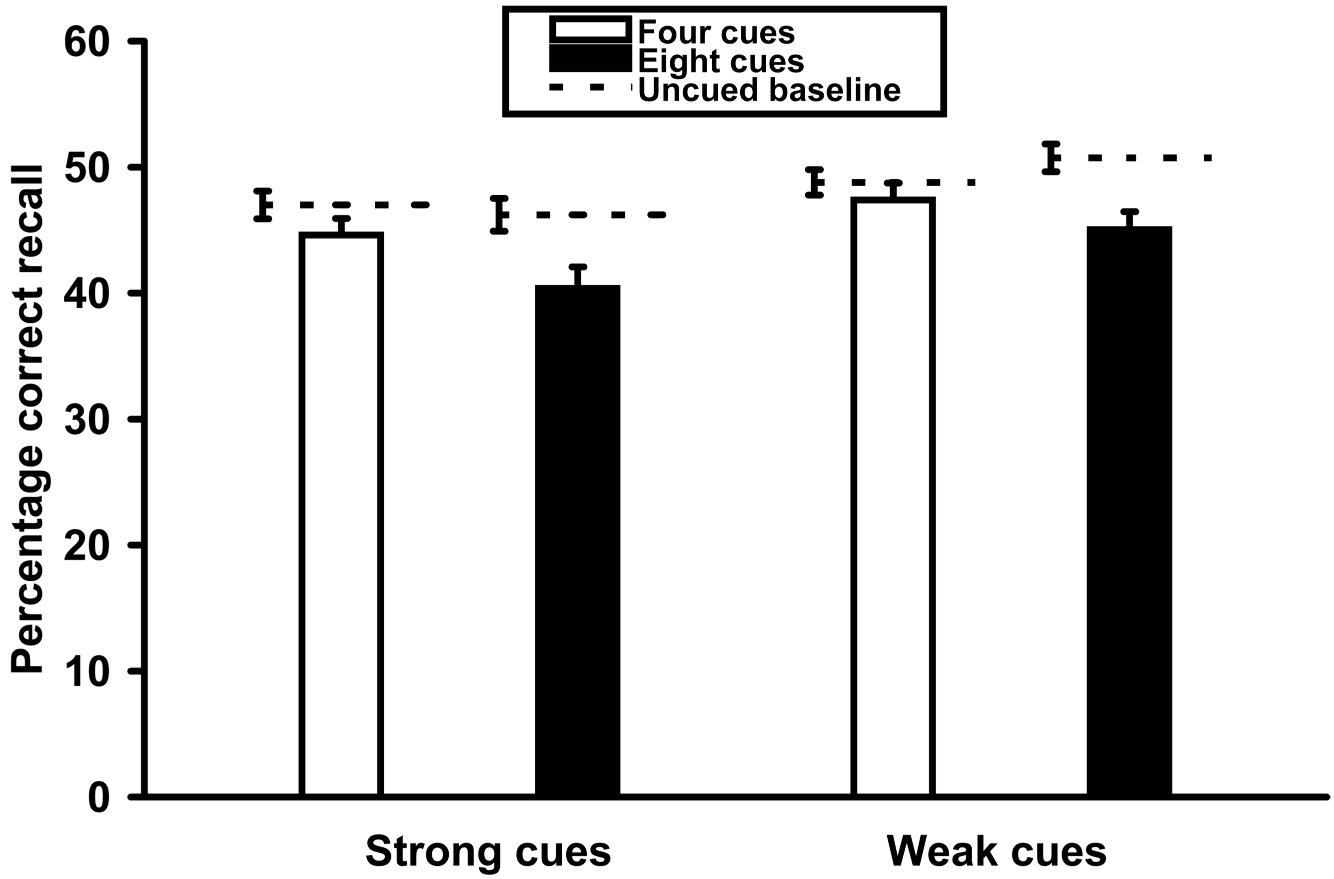


**Figure 4.**
Mean percentage correct recall (and standard errors) for non-cue studied items in the uncued and cued conditions, as a function of cue associative strength and cue number in Experiment 2.

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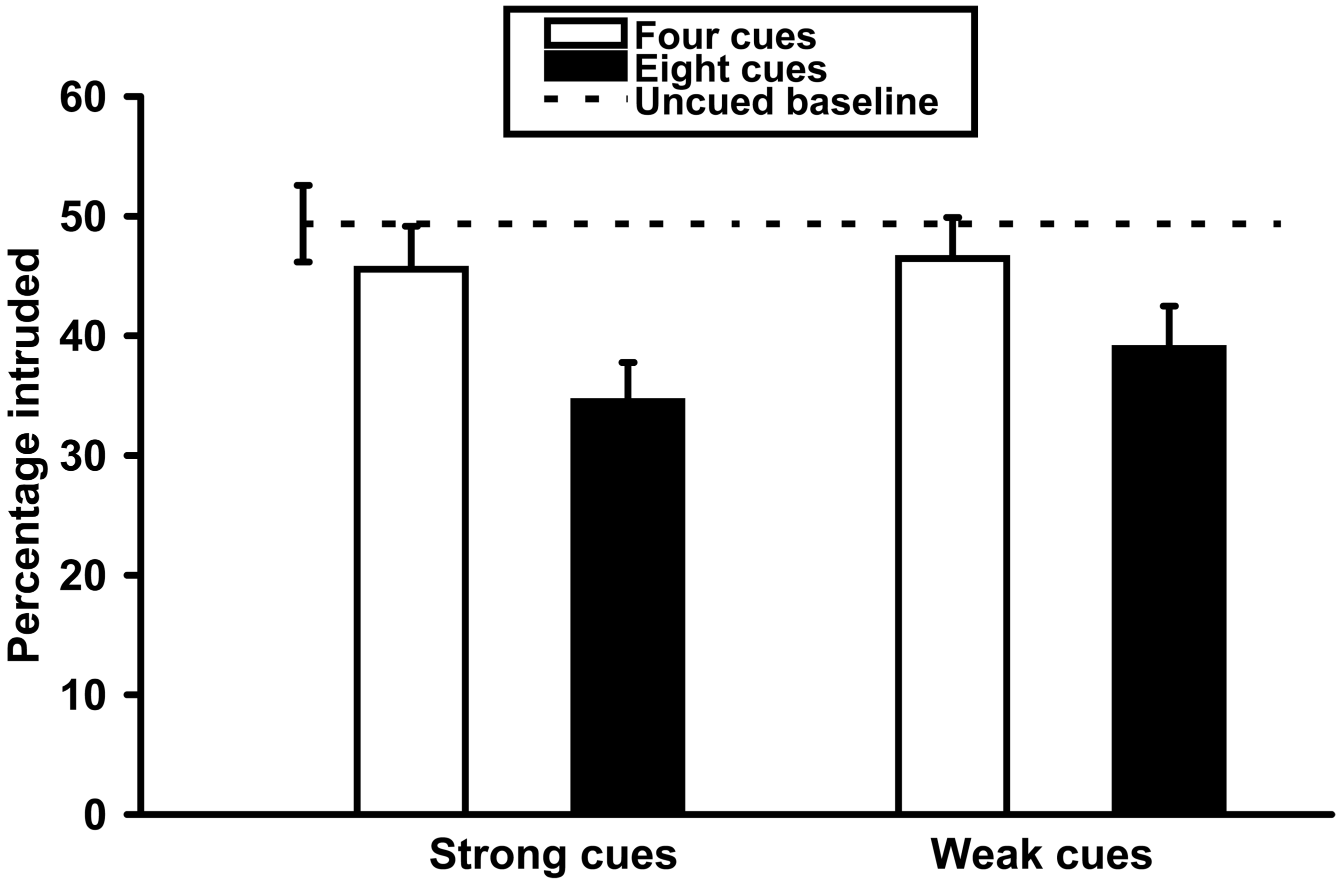


**Figure 5.**
Mean percentage of critical words intruded (and standard errors) in the uncued and cued conditions, as a function of cue associative strength and cue number in Experiment 2.