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Article *in* Journal of Experimental Psychology Learning Memory and Cognition · July 2013

DOI: 10.1037/a0030335 · Source: PubMed

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Journal of Experimental Psychology:
Learning, Memory, and Cognition

0278-7393/12/$12.00 DOI: 10.1037/a0030335

On the Status of Cue Independence as a Criterion for Memory Inhibition: Evidence Against the Covert Blocking Hypothesis

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Retrieving memories can impair recall of other related traces. Items affected by this retrieval-induced forgetting (RIF) are often less accessible when tested with independent probes, a characteristic known as cue independence. Cue independence has been interpreted as evidence for inhibitory mechanisms that suppress competing items during retrieval (M. C. Anderson & Spellman, 1995). Several authors, however, have proposed that apparent cue independence might instead reflect noninhibitory cue-dependent blocking mechanisms. In this view, when participants receive an independent probe test, they do not limit themselves to those probes but instead recall study cues covertly to aid performance. This strategy is thought to be self-defeating, because it reintroduces cues that instigate blocking, lending the appearance of generalized inhibition. M. C. Anderson (2003), in contrast, proposed that covert cuing masks cue-independent forgetting by providing a compound cuing advantage. Here, we replicated cue-independent RIF and documented how access to the original study cues influences this effect. In Experiments 1–2, we found that overtly providing category cues on independent probe tests never increased RIF. Indeed, when we provided categories selectively for items that should suffer the most blocking, a sizable reversal of RIF occurred, consistent with the masking hypothesis. Simply asking participants to covertly retrieve categories eliminated cue-independent RIF, contradicting predictions of the self-inflicted blocking account. Far from causing cue-independent forgetting, covert cuing masks it. These findings strongly support the inhibition account of RIF and, importantly, may explain why cue-independent forgetting is not always found.

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Keywords: ●●●

A fundamental problem in the science of memory is to isolate the mechanisms underlying the forgetting of everyday experience. Over the last century, a number of mechanisms have been proposed that may contribute (see M. C. Anderson & Bjork, 1994, for a review). For example, forgetting may sometimes reflect retrieval failure arising from competition with related traces (McGeoch, 1942). By this account, the cues one uses to retrieve a trace become associated to other memories that compete for retrieval (e.g., J. R. Anderson, 1974; Mensink & Raaijmakers, 1988), with stronger associations blocking weaker ones. Over the last two decades, however, evidence has accumulated indicating that forgetting often arises not merely from competition but from adaptive control processes that resolve competition between memories that contend for selection (M. C. Anderson, 2003; Levy & Anderson, 2002). Retrieval competition is thought to be resolved by an inhibition process that reduces competitor activation, aiding target retrieval. The aftereffects of inhibition on the competitors render them less accessible, contributing to forgetting.

The potential contribution of inhibition can be illustrated with the retrieval practice (RP) paradigm (Anderson et al., 1994). In a common variant, participants encode category-exemplar pairs (e.g., *Fruit–Orange*; *Fruit–Banana*; *Clothes–Shirt*) and later perform retrieval practice on half of the items from half of the categories (retrieval practice phase). That is, given the category and a stem (e.g., *Fruit Or__*), participants are asked to recall the studied exemplar. In a final phase, exemplars are tested with their category and the first letter (*Fruit B____*). Naturally, one finds superior recall for the items that participants practiced (hereinafter, Rp+ items). More in- AQ: 2

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This research was supported by Spanish Ministry of Science and Innovation Grants EDU2008-01111, CSD2008-00048, and PSI2008-05607 to Carlos J. Gomez-Ariza and Teresa Bajo; Spanish Ministry of Science and Innovation Grant PSI2011-25797 to Carlos J. Gomez-Ariza; Grant P08-HUM-3600 from the Andalusian government to Teresa Bajo; and UK Medical Research Council Grant MC-A060-5PR00 to Michael C. Anderson.

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terestingly, unpracticed exemplars of practiced categories (hereinafter, Rp− items) are recalled more poorly than exemplars from baseline categories; that is, categories that were encoded but none of whose members were practiced (hereinafter, Nrp items). This aftereffect of retrieval practice on Rp− items is known as retrieval-induced forgetting (hereinafter, RIF; Anderson et al., 1994). These findings are what one would expect if inhibition had suppressed competing Rp− items during retrieval practice, consistent with a role of inhibition in facilitating selective retrieval.

Although RIF is consistent with a role of inhibition, some results can be explained by both competition and inhibition. Consider the basic phenomenon just described. According to the competition account, retrieval practice strengthens the association between the category and the Rp+ item (e.g., *Fruit–Orange*), making that association stronger than those between that category and Rp− items (e.g., *Fruit–Banana*). Later, when Rp− items are tested with the category-stem cue, presenting the category label may elicit the stronger Rp+ item, blocking access to the Rp− item. Thus, the basic RIF phenomenon is consistent with both competition and inhibition.

Although the basic phenomenon fits both theories, RIF exhibits core properties that strongly favor inhibition (for reviews, see M. C. Anderson, 2003; Levy & Anderson, 2002). In the present article, we consider one important property known as *cue independence*, or the tendency for RIF to generalize to multiple cues (M. C. Anderson & Spellman, 1995). Cue independence is a unique prediction of inhibitory models that provides strong evidence against the sufficiency of pure competition theories. Recently, however, the diagnostic role of cue independence for inferring inhibition has been questioned by findings suggesting that the method for inferring this property—*the independent probe method*—may not provide a pure measure of inhibition but rather is contaminated by hidden competition (Camp, Pecher, Schmidt, & Zeelenberg, 2009). Here we consider the assumptions underlying this alternative view. If they prove correct, cue independence may not be diagnostic of inhibition; if they do not, it would reinforce the value of cue independence for inferring inhibition.

Cue Independence and Inhibition

To distinguish the competition and inhibition accounts, M. C. Anderson and Spellman (1995) introduced the independent probe method. The insight behind this method is that the influence of competition should be eliminated if participants are tested with cues different than the ones used to do retrieval practice. Such different cues could access the target (e.g., *Banana*) but, if designed properly, should not elicit retrieval of practiced items (e.g., *Orange*). So, for example, to avoid eliciting *Orange* (a practiced item), one could replace *Fruit* with a cue related to *Banana* and not *Orange,* like *Monkey B*____. By circumventing the practiced item, independent probes may isolate the activation state of the putatively inhibited item, uncontaminated by blocking. Many studies have shown that when recall is tested with independent probes, RIF still occurs (e.g., M. C. Anderson & Bell, 2001; M. C. Anderson, Green, & McCulloch, 2000; M. C. Anderson & Spellman, 1995; Aslan, Bäuml, & Grundgeiger, 2007; Bajo, Gómez-Ariza, Fernández, & Marful, 2006; Gómez-Ariza, Fernandez, & Bajo, 2012; Hulbert, Shivde, & Anderson, 2012; Johnson & Anderson, 2004; Levy, McVeigh, Marful, & Anderson, 2007; MacLeod & Saunders, 2005; Veling & van Knippenberg, 2004; for exceptions, see Camp, Pecher, & Schmidt, 2007; Perfect et al., 2004; Williams & Zacks, 2001). Thus, RIF often generalizes to a variety of cues through which one might test affected items; that is, RIF is often *cue independent*. AQ: 3

At face value, cue-independent forgetting strongly favors an inhibitory account of RIF over theories that rely strictly on competition. If competing memories are truly inhibited, the effect should generalize to novel cues. Competition accounts, however, predict that forgetting should be cue dependent; RIF should arise only when Rp− items are tested with the cues used during retrieval practice. This dependency follows because it is the associations between these cues and Rp+ items that are strengthened during RP. Thus, presenting the practiced categories as cues on the final test offers the strengthened Rp+ items the opportunity to compete with Rp− items that share those cues. When recall is tested with independent probes, however, no such opportunity arises. Thus, the independent probe technique is potentially useful for isolating inhibition in selective retrieval. The usefulness of this method depends, however, on whether blocking is truly circumvented by independent cues, which we discuss next.

Independent Probes and Covert Cuing

The value of the independent probe method in isolating inhibition recently has been questioned (Camp et al., 2009). Of concern is whether independent cues access target traces in a manner that is truly independent of practiced categories and Rp+ items. Perhaps participants use additional cues during the test. For example, suppose participants receive the extralist independent probe *Food* as a cue for *Tomato* (*Food-To*__), which had been encoded as a Red item (e.g., as *Red–Tomato*). Perhaps participants go beyond using *Food To*______ and recall the studied categories (e.g., *Red*) to aid search. Participants may use this *covert cuing* strategy (M. C. Anderson, 2003), because extralist cues deprive them of the context under which those items were studied (Tulving & Thomson, 1973). Participants may believe that covert retrieval would aid recall because the target was studied with the category and because the category was repeated during retrieval practice. AQ: 4

Covert cuing has been studied recently by Camp et al. (2009), though not in the retrieval-practice paradigm. Participants encoded cue–target pairs (e.g., *Concert Piano*). Prior to this, some cues (e.g., *Concert*) were preexposed twice, making them more accessible. After pair encoding, participants were tested on the targets (e.g., *Piano*) with ostensibly independent extralist categories (e.g., *Instrument for Piano*). Camp et al. reasoned that if the extralist cues (e.g., *Instrument*) accessed *Piano* independently of the study cues (*Concert*), recall should not be affected by whether *Concert* had been preexposed. If, however, participants covertly recalled the cue (e.g., *Concert*) to aid extralist recall, performance should benefit when those cues are more accessible. Camp et al. found that preexposure of the cues (e.g., *Concert*) facilitated recall for their targets (e.g., *Piano*), even though only the independent probes appeared at test (*Instrument*). This *cue-enhancement effect* (Huddleston & Anderson, 2012) suggests that covert cuing sometimes occurs. Thus, in-

Fn1 dependent probes may not always be independent.[1] If so, we must understand how covert cuing influences independent probe tests and, crucially, the amount of RIF.

Covert Cuing and Cue-Independent RIF: Competing Hypotheses

Two hypotheses have been offered for how covert cuing affects independent probe recall. By the *self-inflicted blocking hypothesis*, covert cuing causes cue-independent RIF. Covertly retrieving the category is proposed to expose participants to interference they would not experience if they had not done so (M. C. Anderson, 2003; M. C. Anderson & Bell, 2001; M. C. Anderson & Spellman, 1995; Camp et al., 2009; Perfect et al., 2004) because the category activates all its exemplars and not simply the one that participants seek. Though this unexpected interference should happen for both practiced and baseline categories, interference should affect Rp− items more because (a) practiced categories are highly accessible and so should have more opportunities to interfere and (b) practiced categories should evoke strong Rp+ items. Thus, though participants may believe recalling categories is useful, this strategy ought to backfire and induce blocking. If covert cuing triggers greater RIF on independent probe tests, it weakens this method's value as a tool for isolating inhibition.

In contrast, M. C. Anderson (2003) proposed that covert cuing makes cue-independent RIF harder to observe. According to this *masking hypothesis*, covert retrieval improves recall because having two cues is better than having one. For example, given the extralist cues *Monkey B____*, recall of *Banana* should improve upon recalling the additional cue *Fruit*. The benefits of multiple cues are intuitively clear and are well supported (Dosher & Rosedale, 1997; Massaro, Weldon, & Kitzis, 1991; Rubin & Wallace, 1989; Tulving, Mandler, & Baumal, 1964; Weldon & Massaro, 1996). Indeed, having two cues often yields superadditive benefits because the resulting compound cue constrains responses. For example, Rubin and Wallace (1989) found that the probability of generating "ghost" was 100% when participants received both the rhyming cue *post* and the conceptual cue *a mythical being*; in contrast, "ghost" was never generated (0%) to *rhymes with post* and was generated only 16% of the time to *mythical being*. Such findings suggest that covertly retrieving categories should help.

Adding cues may help recall, but how would this affect RIF on independent probe tests? To make predictions, one must consider two types of retrieval failures: failures arising from inhibition and failures arising because probes are simply not related enough to their targets to elicit them. For items forgotten because of inhibition, adding more cues may not help recall of the forgotten item, as items are inhibited in cue-independent fashion;[2] however, for items not recalled simply because the cue is poor—a *noninhibitory* source of forgetting— adding cues clearly may help recall. In this view, covert cuing improves recall by helping to recover items that would be forgotten for *noninhibitory reasons*, such as weak independent probes. Because participants' chances of getting a weak independent probe should be similar for Rp− and baseline items (i.e., materials are counterbalanced across conditions), people should be equally likely to attempt covert cuing to compensate for poor cues in the two conditions, benefiting both conditions equally. It must be remembered, however, that even if people attempt covert cuing equally often in both conditions, the odds of recalling RP categories should be much greater, owing to their frequent and recent presentation during retrieval practice. For these reasons, M. C. Anderson (2003) hypothesized that Rp− recall would enjoy greater benefits from covert cuing. Because RP categories should be so easy to recall, compound cuing should be possible more often for Rp− items, offsetting any recall deficit due to inhibition and masking cue-independent RIF. Importantly, this masking effect in no way "releases" inhibition on inhibited items; it merely masks the measurement of this effect by contaminating the behavioral index of inhibition (RIF) with greater recovery of noninhibited Rp− items owing to the advantage that RP categories have in the covert retrieval process (cue enhancement).

Hence, different views of how covert cuing affects cue-independent RIF can be advocated.[3] To distinguish these views the current studies evaluated predictions of the self-inflicted blocking and masking hypotheses, helping us to understand how this behavior may influence performance on independent probe tests. Fn3

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The Present Experiments

In the current work, we studied how covert cuing would affect recall, if it were successful, by simulating its dynamics with overt category cuing on an independent probe test. In Experiments 1 and 2, participants performed the retrieval practice procedure with one modification: On the test, the independent probe appeared with the target's first two letters and was followed briefly by the studied category for that target. By overtly flashing the category shortly after the independent probe, we mimicked the category retrieval that the self-inflicted blocking hypothesis claims causes RIF on independent probe tests. In Experiment 1, this category cuing occurred for all NRP and RP items. In Experiment 2, we performed category cuing selectively for Rp items, to simulate how biases in category accessibility affect RIF. Finally, in Experiment 3 participants simply were asked to generate categories covertly to help them recall items that went with the independent probes, prompting them to recruit the strategy at issue. In

[1] The cue-enhancement effect, by itself, does not imply that participants intentionally recalled study cues. For example, extralist probes may elicit spontaneous retrieval of cues via probe–cue associations. Indeed, many cues (e.g., *Beak*) of the pairs used by Camp et al. (2009; e.g., *Beak–Duck*) had relationships to the probes (e.g., *Bird*); it has been demonstrated that when the cues of pairs (*Gate Daisy*) are unrelated to probes (*Flower*), discouraging such spontaneous retrieval, cue enhancement effects disappear (Huddleston & Anderson, 2012).

[2] For simplicity, we assume that adding cues will not help recover inhibited items because of cue independence. However, cue independence does not imply that memories cannot ever be recovered with new or additional cues. It simply implies that recovery, in general, is harder and that this difficulty will span a variety of cues. Recovery may be possible if gradations of inhibition exist, much as gradations in priming exist. None of our predictions rely on this graded inhibition assumption.

[3] Recent studies have disconfirmed clear predictions of the self-inflicted blocking hypothesis. For instance, Hulbert et al. (2012) found that retrieval practice induced more cue-independent RIF (9%) than did extra study exposures (0%), although comparable strengthening of practiced items (23–24%) was found in each case. Moreover, strengthening correlated neither with within-category RIF (r = .07) nor with cross-category RIF (r = .06; N = 96). If covert interference caused cue-independent RIF, RIF should have occurred for extra study exposures and correlated with strengthening. AQ: 13

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all experiments, performance was compared to that in a standard retrieval practice condition where participants received just the independent probe to cue recall.

The two hypotheses make very different predictions. The masking hypothesis predicts that adding cues will benefit recall, and the impact of this benefit on RIF should depend on whether cuing is distributed equally (Experiment 1) or is biased (Experiment 2); if it is distributed equally, all categories should benefit, boosting overall recall with little change to RIF; if it is biased to RP categories, only RP categories should benefit, masking or even reversing RIF. If covert cuing instructions lead people to recall more RP categories, masking may also occur in Experiment 3. In contrast, the self-inflicted blocking hypothesis predicts that manipulations that elicit Rp+ retrieval on independent probe tests should magnify RIF because retrieval of Rp+ items blocks Rp− items. Thus, providing categories at test should increase RIF in Experiment 1 because it should increase interference for both Rp− and Nrp items (from Rp+ and other Nrp items, respectively), but only Rp− items compete with strong Rp+ items, magnifying RIF. In Experiment 2, selectively cuing with RP categories should exaggerate RIF further because Rp− but not Nrp items are subjected to added competition. In Experiment 3, if covert cuing instructions make people more likely to use covert cuing and if RP categories are easier to recall, cue-independent RIF should be exaggerated.

Experiment 1

Experiment 1 compared recall in a *standard condition,* in which an independent cue appeared at test with recall, with that in an *unbiased cuing condition,* in which the relevant category cue appeared shortly after independent probe onset for all Rp and Nrp items. Although this form of unbiased cuing does not mimic covert cuing as it would occur naturally (because covert cuing would be biased toward RP categories, owing to their greater accessibility), this condition tests distinctive predictions of the blocking and masking hypotheses. The masking hypothesis predicts that adding cues should boost overall recall, leaving RIF unaffected because (a) some forgetting on the independent probe test in the standard condition occurs for *noninhibitory reasons*, such as retrieval failure owing to poor cues; (b) the rate of noninhibitory forgetting is similar across Rp− and NRP conditions because we counterbalanced items; (c) cuing "rescues" some noninhibited items by providing better cues; and (d) inhibited items are not rescued by cues, owing to the cue independence of inhibition. Thus, a comparable fraction of noninhibited Rp− and NRP items should be rescued by cues, yielding a main effect benefit and a persisting RIF effect of similar size.

In contrast, self-inflicted blocking predicts that if unbiased cuing improves recall, blocking should increase. Improved recall would confirm that (a) the category cue is being used to recall items that would otherwise be forgotten and (b) the rate of category use must be greater in the unbiased cue condition. Thus, if using the category cue on the test elicits interference from strong Rp+ items and if category use is much more likely in the unbiased cue condition, more Rp− items should be subjected to interference from Rp+ items, causing increased RIF compared to the standard condition, where category use is less.

Method

Participants. Fifty-six students (18–35 years of age) participated in exchange for course credit or a small monetary payment.

Materials. Six categories were constructed based on the materials of Román, Soriano, Gómez-Ariza, and Bajo (2009), which were drawn from Alameda and Cuetos (1995). Four additional items were chosen from two additional categories as fillers for controlling primacy and recency effects. For each category, six exemplars (e.g., *Fruit–Banana*) were chosen. They (a) began with unique first two letters, (b) had no associations with words in other categories, and (c) were 2–4 syllables long. All pairs were in Spanish (see the Appendix for English translations). AQ: 5

Each experimental category contained three high (M = 36.47, SD = 19.54) and three low (M = 6.71, SD = 6.08) taxonomic frequency exemplars, according to Alameda and Cuetos (1995). Participants performed retrieval practice on low-frequency exemplars, to make the retrieval practice task difficult enough to ensure that high-frequency Rp− items would cause enough interference during practice to trigger inhibition (Anderson et al., 1994; Bajo et al., 2006). Because of this frequency variation, Rp+ recall was always compared to low-frequency Nrp items (hereinafter, Nrp-low items), and Rp− items were compared to high-frequency Nrp items (hereinafter, Nrp-high items). These six categories were randomly assigned to two groups, with half receiving retrieval practice and half not receiving it. The categories receiving practice were counterbalanced across participants, with every category appearing in every condition equally often.

We selected cues to be used as independent probes that were related to just one of the targets (e.g., *Monkey* for *Banana*), with a relationship weak enough to avoid ceiling effects (production frequency $<$ .08; Fernández, Diéz, Alonso, & Beato, 2004). Pilot studies successfully demonstrated that when presented with the first two letters of their targets, these cues yielded recall levels ranging from 49% to 92% (M = 69.73%). Independent probes were also selected to be unrelated to their practiced category according to association norms (Fernández et al., 2004). Indeed, we took the extra step of asking pilot participants to seek relationships between each probe and its category, when overtly paired (Huddleston & Anderson, 2012); even under such circumstances, in which participants engage strategic processes to find relationships between items, participants rated our pairs as less than moderately related (M = 2.78 on a 5-point scale). That is, participants rated them as less related than other stimuli (Camp et al., 2009) offered as independent probes (M = 3.62, $p <$ .0000001) but rated them modestly higher than the probe–cue relationships of M. C. Anderson and Green (2001; M = 2.67, p = .04). Because multiple studies have demonstrated that such low levels of subjective relatedness do not produce spontaneous cue-enhancement effects (Huddleston & Anderson, 2012), the standard conditions of the present experiments (in which no covert cuing instructions are provided) should have greatly reduced spontaneous covert cuing.

Procedure. Participants were tested individually. They were asked to memorize word pairs for an upcoming test. Each pair (e.g., *Fruit–Orange*) appeared in the center of the computer screen for 5 s, with a 1-s interstimulus interval. Filler items appeared as the first and last two items to control for primacy and recency effects.

Participants then entered the retrieval practice phase, during which they repeatedly retrieved the three low-frequency Rp+ items from each of the to-be-practiced categories. On each trial, a fixation cross appeared, followed by a category label for 2 s (e.g., *Fruit*), that was displaced for 4 s by the first two letters of the target (e.g., *Or_*). Participants were asked to recall and say the studied exemplar starting with the stem (e.g., *Orange*). Rp+ items appeared in block-

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randomized order. Each block contained one item from each of the three practiced categories, with the constraint that the same pairs would not appear sequentially across blocks. Filler items appeared at the beginning and end of the practice phase and separated blocks of targets. The list was presented three times. After retrieval practice, participants spent four minutes performing simple calculations.

On the final memory test, half of the participants were randomly assigned to the standard condition and half were randomly assigned to the unbiased cue condition. For test trials in both conditions, participants received an independent probe (IP) with the first two letters of the target for 4 s. In the unbiased cue condition, however, the category cue originally paired with the target appeared after 2 s and remained with the IP and stem for the final 2 s. Participants were asked to recall the target corresponding to the cues. To minimize output interference, we divided cues into two blocks so that Rp− and Nrp baseline items were always tested in the first block and Rp+ items were tested in the second. Presentation order was randomized within blocks.

Results

To analyze facilitation and forgetting effects in all experiments, we performed two mixed design analyses of variance (ANOVAs) on the percentage of test items recalled. For each group, we compared performance for Rp+ and Nrp-low items to assess facilitation; we compared Rp− and Nrp-high recall to assess RIF.
T1,AQ:6 Means and standard errors for each condition appear in Table 1.

Retrieval-induced forgetting. A 2 × 2 mixed ANOVA revealed RIF, as observed in a main effect of item type when aggregating over our test types, $F(1, 54) = 10.64$, $MSE = .18$, $p = .002$, partial $\eta^2 = .17$; participants recalled more Nrp-high items ($M = 71\%$, $SD = 16\%$) than Rp− items ($M = 63\%$, $SD = 18\%$). Participants also recalled more items when tested with two cues in the unbiased cuing group ($M = 75\%$, $SD = 16\%$) than when tested with a single cue in the standard group ($M = 59\%$, $SD = 16\%$), $F(1, 54) = 24.32$, $MSE = .74$, $p < .001$, partial $\eta^2 = .31$. Importantly, no interaction between item type and test type occurred, $F(1, 54) < 1$, partial $\eta^2 = .00$, indicating that category cues
F1,AQ:7 did not increase RIF (see Figure 1). These findings thus fail to support a role of category accessibility in determining RIF, contrary to the blocking hypothesis.

Retrieval-based facilitation. Retrieval-practice facilitated Rp+ recall ($M = 83\%$, $SD = 17\%$) compared to Nrp-low baseline items ($M = 69\%$, $SD = 20\%$), $F(1, 54) = 12.52$, $MSE = .54$, $p = .001$, partial $\eta^2 = .19$. Overall recall did not vary across the groups, $F(1, 54) = 1.03$, $MSE = .03$, $p = .315$, partial $\eta^2 = .02$, nor did

Table 1
Mean Percentage Correctly Recalled (and Standard Errors) on the Final Test by Practice Status of the Items and Final Test Type

	Item type							
	Rp−		Nrp-high		Nrp-low		Rp+	
Test type	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Standard condition	55	3	63	3	65	4	84	3
Unbiased cue	72	3	79	3	73	4	82	4

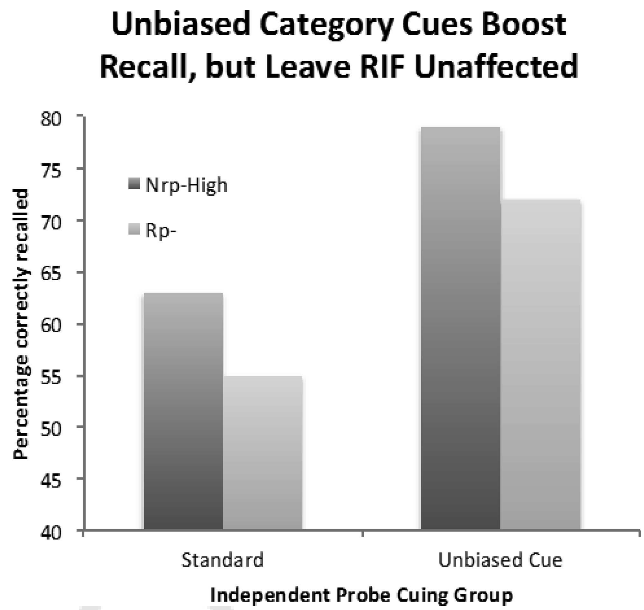

Figure 1. Independent probe recall in the standard and unbiased cue groups for Rp− and matched Nrp-high baseline items. Two trends are apparent: RIF (compare Nrp-high and Rp− items) and an overall improvement in recall in the unbiased cue group.

facilitation vary by group, $F(1, 54) = 1.77$, $MSE = .08$, $p = .189$, partial $\eta^2 = .03$.

Discussion

The results of Experiment 1 are inconsistent with the self-inflicted blocking account. If covertly recalling categories triggered Rp+ items to block Rp− items, overtly presenting these same categories at test should have behaved similarly. The sizable recall advantage in the unbiased cue condition shows that participants benefited from the category cues, indicating that the cues were indeed used. Despite this, RIF did not vary across the unbiased cue and standard groups. The current results are consistent, however, with the masking hypothesis, which predicts similar increases in recall of Rp− and Nrp-high items, owing to "rescue" of items forgotten for noninhibitory reasons. The comparable RIF effects in the standard and unbiased cuing conditions fit the view that inhibitory forgetting is resistant to additional cues, as predicted.[4] Fn4

By presenting categories for all probes, Experiment 1 neglects the role of category repetition in determining whether categories can be covertly retrieved during independent probe tests. Participants should be more likely to covertly recall practiced than baseline categories:

[4] Note that although the absolute recall improvement from the standard to the unbiased cue condition was comparable in the NRP-high (15.85%) and Rp− (16.67%) conditions, the fraction of available forgetting in the NRP-high standard condition (1 − Nrp-high = 1 − .63 = .37) that was rescued by cues (.1585/.37 = .432) was higher than the fraction of forgetting (1 − Nrp-high = .451) rescued by dual cues in the Rp− standard condition (.167/.451) = .3695, a "rescue deficit" of roughly 6.2%. This reflects the fact that the RP− condition includes an inhibition component resistant to recovery by additional cues, whereas the Nrp-high condition does not.

practiced category labels appear nine additional times during retrieval practice (three exemplars practiced three times each) and appear more recently. Indeed, Camp et al. (2009, p. 939) emphasized that enhanced access to Rp+ items and the interference this causes may be instrumental to cue-independent RIF. In Experiment 2, we therefore sought to more accurately simulate covert cuing by biasing the provision of the categories to either Rp or Nrp items.

Experiment 2

In typical RIF studies, Rp categories are likely to be far more accessible than Nrp categories on the final test, because Rp categories are presented repeatedly during retrieval practice. To simulate this bias, in Experiment 2, the *Rp-bias* group received the category for Rp but not Nrp items. Presenting the category for Rp− items ensures access to the category on the IP test, maximizing the potential for blocking. By not presenting the category for Nrp items, we simulated reduced access to category cues in that condition. To test further predictions, we also included an *Nrp-bias* group, which received the category for Nrp but not Rp items. The self-induced blocking hypothesis predicts that the Rp-bias procedure should exaggerate RIF; in contrast, the Nrp-bias procedure should attenuate RIF, by introducing modest interference (from the Nrp-low items) during retrieval of critical Nrp items.

The masking hypothesis, by contrast, predicts that cuing will facilitate recall. Thus, biasing category cuing toward Rp items should enhance Rp− recall, relative to that for Nrp-high items for which no additional cues are provided. Thus, even if inhibited items remained inhibited despite added cues, the better access to noninhibited items afforded by the new cues should mask RIF. Depending on how much category cuing helps Rp− items, the effect may range from a simple reduction in RIF to a significant reversal. Regardless of such variation, however, RIF should be reduced, compared to the standard condition. Presenting a second cue selectively for Nrp items, however, should enhance Nrp recall, inflating RIF. This would reflect not greater inhibition but a bias in cue information for baseline categories. Thus, the two hypotheses make opposite predictions about how category cuing influences RIF in the RP− and NRP-bias conditions, relative to the standard cuing condition.

Method

Participants. Seventy-two new participants (18–35 years of age) from the universities of Granada and Jaen took part for course credit or a small payment.

Materials. We used the materials of Experiment 1.

Design and procedure. We used the procedure of Experiment 1 except for the independent probe test, on which category cuing varied by condition. The standard condition received only an independent probe at test. The RP-bias condition received an additional category cue only for items from practiced categories (i.e., Rp− and Rp+ items), whereas the NRP-bias condition received the category cue only for Nrp items.

Results

T2 Table 2 shows means and standard errors for each condition in Experiment 2.

Retrieval-induced forgetting. The 2 (item type) × 3 (test type) mixed ANOVA revealed significant RIF when aggregating over our test types, $F(1, 69) = 8.07$, $MSE = .19$, $p = .006$, partial $\eta^2 = .11$; participants recalled fewer Rp− items ($M = 58\%$, $SD = 23\%$) than baseline items ($M = 65\%$, $SD = 17\%$). Recall did not vary overall by test type, $F(2, 69) = 2.56$, $MSE = .08$, $p = .085$, partial $\eta^2 = .07$.

Table 2
Mean Percentage Correctly Recalled (and Standard Errors) on the Final Test by Practice Status of the Items and Final Test Type

	Item type							
	Rp−		Nrp-high		Nrp-low		Rp+	
Test type	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Standard condition	52	3	62	3	67	4	88	3
RP-bias	76	4	55	3	61	5	89	3
NRP-bias	45	4	78	3	71	4	80	4

The pivotal question concerns, however, how RIF varied by test type. As Figure 2 illustrates, RIF did vary across the standard, RP-bias, and Nrp-bias groups, as reflected by a robust interaction of item type with test type, $F(2, 69) = 39.48$, $MSE = .93$, $p < .001$, partial $\eta^2 = .53$. The standard condition exhibited RIF, $F(1, 23) = 5.62$, $MSE = .12$, $p = .027$, partial $\eta^2 = .20$, replicating Experiment 1 and, importantly, independent probe inhibition broadly. Crucially, the RP-bias condition exhibited a highly significant reversal of RIF, $F(1, 23) = 17.36$, $MSE = .57$, $p < .001$, partial $\eta^2 = .43$. As Table 2 illustrates, Rp− items were recalled far better ($M = 76\%$) than Nrp-high items ($M = 55\%$). In contrast, the NRP-bias condition showed exaggerated RIF, $F(1, 23) = 80.54$, $MSE = 1.36$, $p < .001$, partial $\eta^2 = .78$, with Rp− items ($M = 45\%$) recalled far more poorly than Nrp-high items ($M = 78\%$). This dramatic crossover pattern—a 56% difference in RIF—strongly confirms the masking hypothesis (M. C. Anderson, 2003) and speaks powerfully against self-inflicted blocking.[5] F2 Fn5

Retrieval-based facilitation. Rp+ items benefited from retrieval practice ($M = 86\%$, $SD = 17\%$; Nrp-low items, $M = 66\%$ and $SD = 21\%$), $F(1, 69) = 38.40$, $MSE = 1.35$, $p < .001$, partial $\eta^2 = .36$, but this facilitation varied across test conditions, $F(2, 69) = 3.11$, $MSE = .11$, $p = .050$, partial $\eta^2 = .08$. Reliable facilitation occurred in the standard, $F(1, 23) = 20.86$, $MSE = .52$, $p < .001$, partial $\eta^2 = .47$, and RP-bias conditions, $F(1, 23) = 20.82$, $MSE = .95$, $p < .001$, partial $\eta^2 = .46$, but not in the NRP-bias condition, $F(1, 23) = 2.89$, $MSE = .10$, $p = .103$, partial $\eta^2 = .11$. Reduced facilitation in the latter condition is expected because of the inflation of Nrp-low recall by category cuing.

[5] Unexpectedly, we also found that items not receiving a category cue were recalled about 7% more poorly in the RP-bias and Nrp-bias conditions, compared to the corresponding items in the standard condition. Recall for these noncued items might have been artificially reduced if participants, waiting for the category, occasionally did not respond on time. Such confusion could have biased our results against finding a pattern consistent with blocking. Speaking against this, we found that Rp− items in the RP-bias condition were recalled better than Nrp-high items in the standard condition ($p < .01$), even though the latter could not be influenced by this confusion. Similarly, Nrp- items in the Nrp-bias condition were recalled better than Rp− items in the standard condition ($p < .001$). AQ: 14

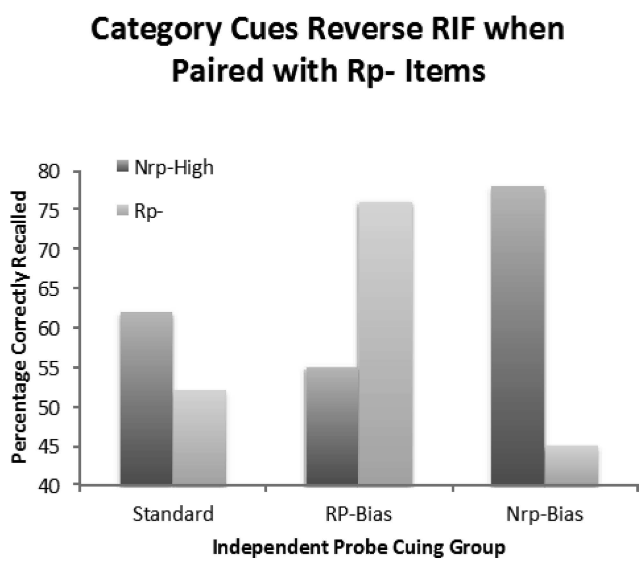

Figure 2. Independent probe recall in the standard, Rp-bias, and Nrp-bias groups for Rp− and matched Nrp-high baseline items. The effect of adding categories is clear: Recall is facilitated dramatically, depending on whether cues are provided for Rp− items (the Rp-bias group) or for Nrp items (the Nrp-bias group). Selective cuing reverses RIF in the Rp-bias group and exaggerates it in the Nrp-bias group.

Discussion

Experiment 2 established that recall increases whenever a category cue is added to an independent probe. Consequently, when we mimicked likely biases in category accessibility (i.e., by providing the category only for items from practiced categories), RIF not only failed to increase, it reversed. The NRP-bias condition, in contrast, showed exaggerated RIF. The present findings thus compellingly argue against self-inflicted blocking as a cause of cue-independent RIF. They strongly support the view that covert cuing masks cue-independent RIF (M. C. Anderson, 2003).

Experiment 3

Although Experiment 2 suggests that self-inflicted blocking does not cause cue-independent RIF, overt and covert cuing may differ and our simulations may thus not be representative. Perhaps overt cuing with categories led participants to use a semantic retrieval strategy on the independent probe test instead of episodic recall. Thus, despite our clear episodic recall instructions, testing with cues such as *Monkey B____ Fruit* might have led participants to sometimes generate *Fruits* from general knowledge that were related to the cues *Monkey* and *B.* True covert cuing, in contrast, may necessitate access the original retrieval practice context, and this might cause more pronounced blocking by strong Rp+ associations encountered in that context. Perhaps self-inflicted blocking would emerge if we used covertly retrieved categories.

To address these possibilities, Experiment 3 manipulated whether people were asked to use covert cuing. To our surprise, this simple manipulation has never been reported, despite its clear utility as a test of self-inflicted blocking. In Experiment 3, all participants received the independent probe test used in the standard condition of the prior experiments. However, in the *instructed group*, participants were informed about the usefulness of covertly recalling studied categories and were encouraged to do this; the *standard group* received standard instructions. If our overt cuing manipulation was unrepresentative, asking participants to generate covert cues on their own should reveal RIF. Moreover, if instructions increase covert cuing, more RIF should occur in the instructed than in the standard group, if covert cuing triggers independent probe RIF.

The masking hypothesis, by contrast, makes two predictions. First, recalling a category should improve recall of an exemplar, because having the additional category should elicit more items forgotten for noninhibitory reasons. Thus, overall recall should improve. Second, covert cuing should reduce the amount of RIF. Because RP categories are more accessible than NRP categories, Rp− items should enjoy greater access to compound cuing, masking RIF. Depending on how much more accessible RP categories are, RIF may simply be reduced, compared to the standard condition, or indeed may be reversed as in our prior Rp-bias condition.

Method

Participants. Forty-eight new participants (18–35 years of age) from the universities of Granada and Jaén took part for course credit or payment.

Materials. We used the same materials as in Experiment 1.

Design and procedure. We adopted the procedure used in the standard independent probe condition of Experiment 1 but varied the test instructions given across groups. The standard group received the standard instructions; the instructed group was also encouraged to recall studied categories to help access the target for each probe. Those in the instructed group were given the following additional instruction:

> Importantly, if you are having a hard time recalling the studied items from the provided cues, we strongly encourage you to think back to the categories that went with the target words earlier in the experiment. It usually helps. For example, if you are trying to recall the item you studied, given the hints Balloon He____, thinking back and recalling the category "Gases" may help you to recall that you saw "Helium" in the earlier lists.

Results

Table 3 illustrates the means and their standard errors in Experiment 3. T3

Retrieval-induced forgetting. Covert cuing benefited overall recall, with greater recall in the instructed condition (M = 63%, SD = 16%) than in the standard condition (M = 51%, SD = 21%), $F(1, 46) = 7.61$, $MSE = .33$, $p = .008$, partial $\eta^2 = .14$. More

Table 3
Mean Percentage Correctly Recalled (and Standard Errors) on the Final Test by Practice Status of the Items and Final Test Type

	Item type							
	Rp−		Nrp-high		Nrp-low		Rp+	
Instruction	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Standard condition	46	4	56	5	59	4	74	4
Covert cuing instructions	64	3	61	3	62	3	80	5

F3 important, as Figure 3 illustrates, RIF interacted with instruction group, $F(1, 46) = 4.51$, $MSE = .12$, $p = .039$, partial $\eta^2 = .09$. Whereas the standard condition showed RIF, $F(1, 23) = 6.06$, $MSE = .13$, $p = .022$, partial $\eta^2 = .21$, the instructed condition did not ($F < 1$), converging with Experiments 1 and 2 in confirming the predictions of the masking hypothesis.

These findings could be reconciled with self-inflicted blocking if covert cuing instructions affected practiced and baseline categories differentially. Perhaps RIF in the standard conditions of Experiments 1–3 arises exclusively from self-inflicted blocking, reflecting more successful covert retrieval of practiced than baseline categories. If people already retrieve practiced categories in the standard condition, covert cuing instructions may only increase the number of Nrp categories retrieved. Increased covert retrieval of Nrp categories may reduce RIF by deflating Nrp recall, assuming covert retrieval leads Nrp items to suffer more interference from within-category competitors. Such a hypothesis predicts, however, that, relative to the standard condition, the instructed condition should show (a) no change in Rp− recall and (b) decreased Nrp recall. Neither pattern occurred. Rather, reduced cue-independent RIF reflects (a) robustly increased Rp− recall (18%) and (b) a modest increase in Nrp recall (5%). Thus, covert cuing preferentially enhanced Rp− items, consistent with the RP-bias group of Experiment 2 and the masking hypothesis.

Retrieval-based facilitation. Retrieval practice facilitated Rp+ recall ($M = 77\%$, $SD = 21\%$) relative to Nrp-low recall ($M = 61\%$, $SD = 19\%$), $F(1, 46) = 14.90$, $MSE = .63$, $p < .001$, partial $\eta^2 = .244$, and facilitation did not interact with instructions ($F < 1$).

Testing further predictions of the self-inflicted blocking hypothesis. The self-inflicted blocking hypothesis makes further predictions that we can evaluate against the aggregated data from Experiments 1–3. Blocking attributes apparent cue-independent RIF to retrieval-based strengthening, which leads to several predictions. First, retrieval practice success should predict Rp+ facilitation, reflecting the causal role of practice in inducing strengthening. Second, greater Rp+ facilitation should predict more RIF. Finally, if successful practice causes facilitation, practice success should also predict cue-independent RIF, with increasing success linked to greater RIF.

To test these predictions, we aggregated across the 76 participants from the standard conditions of Experiments 1–3, which were identical and were not affected by other manipulations. Practice success in this aggregate standard condition was 77% (compared to 74% in other conditions), typical of prior work. Variations in this measure correlated with Rp+ facilitation ($r = .32$, $p = .004$), suggesting that successful practice strengthened Rp+ items. Practice success did not, however, predict RIF ($r = .0$, *ns*). Importantly, not only did Rp+ strengthening fail to predict RIF, it was negatively related to it ($r = -.24$, $p = .04$).[6] Thus, two central predictions of blocking—that RIF should increase with practice success and with Rp+ facilitation—were not supported. Fn6

Perhaps the foregoing negative results arose because Rp+ facilitation on an independent probe test is insensitive to a key factor for blocking (i.e., the association strength linking the practiced category to the Rp+ exemplar). Such a concern is hard to reconcile with the need to assume this factor to explain cue-independent RIF with blocking. Nevertheless, to evaluate this possibility, we correlated Rp+ facilitation with RIF in the unbiased cue group of Experiment 1 and the instructed condition of Experiment 3. The unbiased cue group benefited from receiving the category at test, so we can assume that category–exemplar associations are available. As one might hope, practice success predicted Rp+ facilitation ($r = .62$, $p = .0003$). Again, however, neither Rp+ facilitation nor practice success predicted RIF ($r = .09$, $p = .64$; $r = -.03$, $p = .87$, respectively). Similar findings arose in the instructed condition of Experiment 3. Practice success predicted Rp+ facilitation ($r = .62$, $p = .009$); but neither practice success ($r = -.21$, $p = .30$) nor Rp+ strengthening predicted cue-independent RIF ($r = -.10$, $p = .64$). These findings do not support the view that cue-independent RIF—or indeed, RIF in general—is related to Rp+ strengthening.[7] Fn7

Discussion

The results of Experiment 3 suggest that the lessons of Experiments 1 and 2 about compound cues are representative of what happens during covert cuing. They provide little support for the idea that self-generated covert cuing is more likely to generate blocking be-

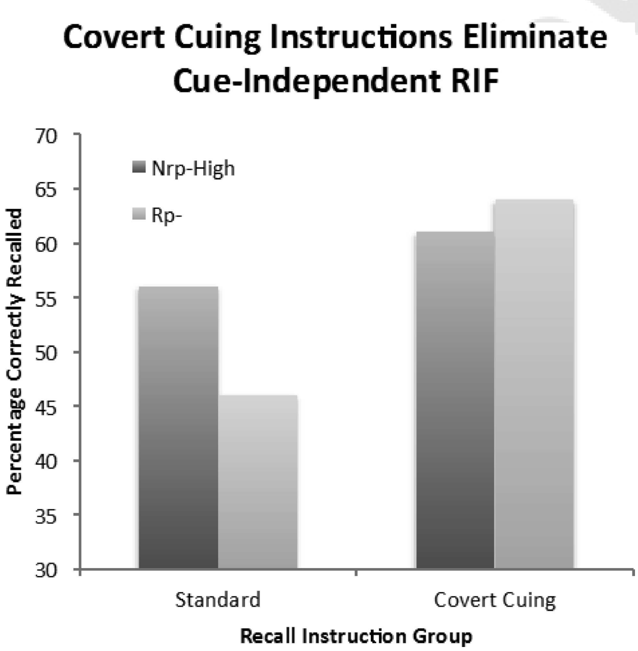

Figure 3. Independent probe recall in the standard and covert cuing groups for Rp− items and matched Nrp-high baseline items. Two trends are apparent: an overall improvement in recall when participants use covert cuing and the elimination of RIF (compare Nrp and Rp−) for the covert cuing group.

[6] This finding is consistent with the idea that inhibition is engaged more when retrieval is difficult. Difficult retrieval is likely to be less successful and to facilitate practiced items less, and because retrieval success is not essential for inhibition (Storm et al., 2006), a negative correlation should be possible according to inhibition.

[7] We computed strengthening as the difference between Rp+ and Nrp-low recall. It must be noted that although matched for materials, Nrp-low items were tested earlier than were Rp+ items, rendering the latter more subject to output interference, possibly deflating our estimate of strengthening. Nevertheless, we observed robust strengthening comparable to that in previous studies, and reductions in this effect by output interference would affect all participants. Thus, correlations of strengthening with RIF should still arise, if variations in strengthening cause variations in RIF, particularly given that strengthening robustly correlates with practice success.

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cause it is more episodic in nature. Experiment 3 shows that when instructed, participants can, in principle, retrieve categories covertly some of the time, at least with small numbers of categories, as suggested by M. C. Anderson (2003). More important, however, covert cuing improves overall recall and eliminates cue-independent RIF: Rp− items differentially benefited by instructions to covertly recall categories, the opposite of what should occur according to blocking. Thus, together with Experiments 1 and 2, Experiment 3 does not support the self-inflicted blocking account of cue-independent RIF.

General Discussion

Over the last two decades, a substantial body of evidence has favored the idea that selectively retrieving a trace inhibits other memories that interfere with retrieval, causing RIF. An important form of evidence for inhibition is the tendency for RIF to generalize to a variety of cues for testing the affected memory. This generalized impairment, known as cue independence, suggests that RIF reflects an enduring disruption to the memory itself and not of any particular pathway into it (M. C. Anderson & Spellman, 1995). Whether cue independence is evidence for inhibition, however, depends on an assumption: that participants given an independent probe test restrict themselves to the independent cues. If participants seek additional cues, we must understand how this influences performance to appreciate its implications for inhibition and competition theories of forgetting.

The present experiments studied how covert cuing affects RIF on independent probe tests. Our approach was simple: We tried to simulate how covertly retrieving the studied category affected recall from an independent probe (e.g., *Monkey Ba*____) by providing the category (e.g., *Fruit*) briefly a few seconds into the trial. This permitted us to ask what would happen if covert cuing was perfect and unbiased (Experiment 1) or, instead, was biased toward baseline or practiced categories (Experiment 2). A simple rule characterizes our findings: presenting a category boosts recall, consistent with compound cuing benefits (e.g., Dosher & Rosedale 1997; Massaro et al., 1991; Rubin & Wallace, 1989). Thus, when appearing for all items, categories improved overall recall, leaving RIF unaffected (Experiment 1); when appearing for practiced categories, Rp+ and Rp− recall improved, reversing RIF; and when appearing for baseline categories, baseline recall improved, exaggerating apparent RIF (Experiment 2). Giving categories for RP− probes never increased RIF.

Given these benchmarks, covert cuing should reduce or reverse cue-independent RIF under standard independent probe conditions, based on the greater accessibility of practiced categories. Experiment 3 confirmed these predictions: Instructing people to use covert cuing reduced RIF. Experiment 3 thus indicates that the lessons learned from our overt cuing manipulations apply to covert cuing strategies. These findings have significant implications for the self-inflicted blocking hypothesis and for interpretations of several reported failures to observe cue-independent RIF. We discuss these in turn.

The Self-Inflicted Blocking Hypothesis and Cue-Independent RIF

The findings of Experiments 1–3 are difficult to reconcile with the proposal that self-inflicted blocking underlies cue-independent RIF (Camp et al., 2009). This hypothesis emphasizes a putative tendency for practiced categories to elicit Rp+ items that block recall of Rp− items. Blocking is proposed to arise on independent probe tests because participants covertly generate the studied categories, triggering (ironically) blocking that undermines recall. This view predicts that increasing participants' use of categories for recalling Rp− items on independent probe tests should exaggerate RIF.

No finding from our experiments supported this prediction. In Experiment 1, providing category cues for all items left RIF unaltered, even though overall recall improved, showing that participants used the categories. In Experiment 2, selectively providing categories for Rp items dramatically reversed RIF when it should have maximized it. Indeed, in the Rp-bias condition, only two out of 24 participants showed RIF, with nearly all others showing reversals. Category cuing for Nrp items, in contrast, dramatically exaggerated RIF, when it should have reduced it. Crucially, in Experiment 3, cue-independent RIF disappeared when people covertly retrieved categories. If this behavior caused cue-independent RIF, requesting it from people should have exaggerated the effect. Thus, in every case, our findings fail to confirm or plainly contradict the predictions of this hypothesis.

We considered the possibility that the foregoing patterns might have arisen if participants used semantic instead of episodic retrieval in response to our category cues in Experiments 1 and 2, despite our instructions to recall studied items. Thus, the boost in recall with category cuing may reflect semantic retrieval and not true episodic retrieval. Although semantic retrieval might have contributed to performance, it could only explain the absence of blocking in Experiments 1 and 2 if we make the very strong assumption that semantic retrieval can proceed independently of participants' recent episodic experience with the categories. For instance, we would need to assume that upon viewing the category cue at test, (a) participants did not recognize it as one that they had seen in the study context, despite having seen it 15 times in the prior 30 minutes; (b) the category did not elicit retrieval of any of the three strong Rp+ items associated to it, despite our instructions to use these cues to recall items from the study context and despite those items having been repeatedly practiced only moments earlier; and (c) semantic retrieval of Rp- items could proceed unhindered by Rp+ items. Though possible, these assumptions seem unrealistic, particularly given the evidence for interdependencies between semantic generation and episodic retrieval (Bäuml, 2002; Starns & Hicks, 2004; Storm, Bjork, Bjork, & Nestojko, 2006). Second, and crucially, even when we asked participants to generate category cues on their own by accessing prior experimental contexts, as they would be expected to do under normal conditions of covert cuing, the data still failed to reveal evidence for blocking and remained consistent with the masking hypothesis.

The failure of blocking to predict the pattern of recall for any of our manipulations suggests that blocking did not play a powerful role in dictating recall, at least under the conditions studied. Of course, one still might maintain that blocking contributed to performance but was outweighed by the compound cuing benefits of retrieving (or being provided with) the category cue for Rp− items. Although a reasonable possibility, this no longer constitutes a viable account of cue-independent RIF, because it fails to explain why RP- items are recalled more poorly than NRP items on independent probe tests, given that such a compound cuing advantage necessarily accompanies the covert category retrieval that putatively generates blocking. More problematically, however, even this weaker contribution of blocking to performance receives little support in our data. If covert blocking truly influenced performance, Rp+ strengthening should have predicted the amount of RIF observed, but it did not: Both Rp+ facilitation and practice success (which were correlated with one another) were uncorrelated or even negatively correlated with RIF. These findings echo many studies showing that strengthening fails to predict RIF, whether on category cued recall (Hulbert et al., 2012), category plus fragment cued recall (Hanslmayr et al., 2010; Staudigal et al., AQ: 8 2010), or recognition tests (Bäuml & Aslan, 2011; Ortega, Gómez-Ariza, Román, & Bajo, 2012; Román et al., 2009). Thus, though one might maintain that blocking still contributes to performance, there is little reason to believe this based on the present findings. At a minimum, however, whatever detrimental effect blocking had on recall was far outweighed by the potent effects of compound cues, which largely dictated how covert cuing influenced RIF on independent probe tests, indicating that covert blocking is unlikely to provide a tenable account of cue-independent RIF.

The Masking Hypothesis and Cue-Independent RIF

The present findings strongly support the masking hypothesis (M. C. Anderson, 2003). According to this hypothesis, covert cuing improves independent probe recall by accessing noninhibited items that would otherwise be forgotten, because our probes were poor or because target encoding was weak. Covert cuing should access few inhibited items, which should be resistant to cues, owing to inhibition. As with the blocking hypothesis, practiced categories are presumed to be more accessible; but unlike blocking, this confers a compound cuing advantage to Rp− items, relative to the benefit enjoyed by Nrp items (M. C. Anderson, 2003).

The key predictions of this hypothesis were confirmed. Presenting category cues at test improved recall. The constant benefit to recall coupled with intact RIF arising when cuing was held constant across conditions (Experiment 1) is predicted from (a) inhibited items' hypothesized resistance to recovery by additional cues and (b) items forgotten for noninhibitory reasons (the frequency of which would not be expected to differ across conditions) benefiting from added cues. The selective benefit to Rp− items arising when cuing was biased toward practiced categories (Experiment 2) is predicted by the greater availability of compound cuing for Rp− items, offsetting detrimental effects of inhibition. Importantly, the disproportionate benefit to Rp− items from greater category accessibility was predicted and observed when participants were asked to covertly cue (Experiment 3), masking RIF.

These strong confirmations of the masking hypothesis thus suggest that far from causing cue-independent forgetting, covert cuing reduces this effect under the conditions most likely present when covert cuing occurs naturally (greater accessibility of Rp categories). If so, difficulties in observing cue-independent forgetting may often arise because true inhibitory effects are masked by a compound cuing advantage provided by covert cuing (Anderson, AQ: 9 2004).

Critiques of Cue-Independent RIF Revisited

The present studies establish benchmarks for how covert cuing influences independent probe performance. The principles reinforced here are that (a) adding cues improve performance, particularly when cues are strongly related to a target; (b) study cues can be covertly retrieved to augment search from extralist probes when people are asked to do so and there few study cues; (c) success at this varies with cues' accessibility; and (d) strong competing associations attached to covertly generated cues do little to offset (if they affect at all) the advantage of additional cues. Here we discuss the implications of these principles for interpreting cases in which cue-independent forgetting was not found and for self-inflicted blocking interpretations offered for cue-independent probe data.

Camp et al. (2007). Camp et al. (2007) reported experiments suggesting that RIF is cue dependent. They tested exemplars from four-item categories with extralist independent probes, each related to one exemplar and no others. For example, if participants studied *Animal–Horse, Animal–Donkey, Animal–Rat,* and *Animal–Hamster,* the probes for *Horse* and *Rat* were *Cowboy H___*, *Poison R____*. Importantly, retrieval practice on *Animal Horse* and *Animal Donkey* did not impair retention of *Rat* and *Hamster* on this test. When participants were tested with the studied category and a stem (e.g., *Animal–R*), however, RIF was observed, leading Camp et al. to conclude that RIF was cue dependent, consistent with interference.

Although they fit cue-dependent forgetting, these findings must be reconciled with other demonstrations of cue-independent forgetting. Toward this end, Camp et al. (2007) argued that evidence for cue-independent forgetting had a common flaw: The independent probes were not item specific. For instance, Anderson et al. (2001), reported that retrieval practice on items such as *Red-Blood* AQ: 10 and *Red-Fire* impaired other red things (e.g., *Red Tomato* and *Red Meat*), when they were tested with extralist independent probes, such as *Food T___* and *Food M___*. Camp et al. (2007) argued that because people studied several foods under the Red category, the "food" feature was salient at encoding, associating it to *Red.* If so, perhaps *Food* was not independent (see also Perfect et al., 2004). Thus, the independent probe (*Food T__*) may have led participants to covertly retrieve the category (*Red*), causing self-inflicted blocking from Rp+ items.

The present findings question this account of Anderson et al.'s (2001) data. If participants had used covert cuing in that study, cue-independent forgetting would have been eliminated. As shown here, accessing studied category cues improves recall. Because Anderson et al.'s participants likely had a big category access advantage for Rp− items (each category appearing 12 times in retrieval practice phase), their findings should have resembled those of Experiment 3. Indeed, when Anderson et al. divided participants by self reports, participants using a covert retrieval strategy showed reduced RIF, as would be expected. As such, the cue-independent RIF in Anderson et al. (2001) likely occurred despite covert cuing, not because of it. Given that blocking is unlikely to underlie those data, inhibition provides a better account.

If Anderson et al.'s (2001) data reflect inhibition, why didn't Camp et al. (2007) observe cue-independent RIF? The present experiments tell us that their lack of cue-independent RIF is not due to use of item-specific independent probes, as they argued. We used that testing method as well, yet the standard conditions of Experiments 1–3 yielded cue-independent RIF, extending work establishing cue independence with item-specific probes (Aslan, Bäuml, & Grundgeiger, 2007; Aslan, Bäuml, & Pastötter, 2007; Bajo et al., 2006; Gómez-Ariza et al., 2012; Johnson & Anderson, 2004; Levy et al., 2007). Rather, a more likely account is that

Camp et al.'s (2007) participants used the very covert cuing strategy they posit, masking cue-independent forgetting.

Several observations recommend a masking interpretation of Camp et al.'s (2007) data. First, baseline recall on Camp et al.'s test was low (39% in Experiment 2, 30% in Experiment 3) compared to baseline recall in the present studies (around 60%) and in Anderson et al.'s (2001) study (around 50%). Camp et al. emphasized that participants' difficulties using extralist cues may trigger them to seek more useful cues. By this argument, their participants had more incentive to use covert cuing. Second, in Camp et al.'s second experiment, participants received 10 s for recall, far exceeding our test durations (4 s) and what we recommended to discourage covert cuing (4 s; see M. C. Anderson, 2003). Finally, masking explains a puzzling tendency in their data not readily explained by interference: the tendency for Rp− items to be recalled better than Nrp items on their independent probe test (7.3% in Experiment 2, 6% in Experiment 3; p = .20, in each case). As we show here, masking not only can eliminate RIF but can also reverse it, depending on the relative accessibility of practiced and baseline categories. Although the masking account of their data remains speculative, it would, if true, render their findings consistent with the present data and with the inhibition account of cue-independent forgetting more broadly.

Perfect et al. (2004). Perfect et al. (2004) also reported experiments suggesting that RIF is cue dependent. Unlike Camp et al. (2007), however, they tested recall with episodic independent probes. Participants studied category–exemplar pairs, each with a unique face. Participants were told to associate the exemplar to its category and to the face, so that if given either, they could recall the exemplar. Retrieval practice was done with category-plus-stem cues (Experiment 1) or with both the category-plus-stem cue and the face (Experiment 2). Final recall was tested with the category alone, the face alone, or with both, in different groups. A third experiment attached a unique word to each exemplar instead of a face.

Perfect et al. (2004) found RIF when testing with category-cued recall but not with independent probes (i.e., the face or word). When they tested with both the category and the probe (Experiments 1–2 only), results were mixed, with either no RIF (Experiment 1) or RIF (Experiment 2). Perfect et al. accounted for their data with blocking mechanisms driven by the match between test cues/context and Rp+ items and the practice context. By this account, whenever cues for Rp− items are associated to practiced items (i.e., the category) or to the practice context, Rp+ items interfere. To explain prior demonstrations of cue independence, they appealed to covert cuing and self-inflicted blocking (highlighting Anderson et al., 2001).

The cue-independent forgetting in Experiments 1–3 sheds doubt on Perfect et al.'s (2004) account. As discussed earlier, our studies used item-specific probes, and there is less reason to suppose that our probes were encoded in relation to the category, as was proposed to AQ: 11 occur for Anderson et al.'s (2004) study. More crucially, our findings suggest that covert cuing would not produce the blocking they proposed but rather masking. Thus, these cases of cue-independent forgetting remain unexplained by their hypothesis and are more likely to reflect inhibition. If so, why did Perfect et al. observe a cue-dependent pattern?

Perhaps cue-dependent forgetting arose because Perfect et al. (2004) used episodic independent probes. This account seems unlikely, given demonstrations of cue-independent RIF with episodic probes (M. C. Anderson & Bell, 2001; M. C. Anderson & Spellman, 1995; Hulbert et al., 2012). In a striking example, Gómez-Ariza et al. (2012) asked people to encode orthographic categories. Participants studied pairs beginning with stems (e.g., *DI–Dilemma*; *DI–Digress*; *RE–Report*; *RE–Rewind*) and then performed retrieval practice in which they received the category (e.g., *Di*), followed 2 s later by a stem (e.g., *Di–Dil*). This type of retrieval practice is known to induce forgetting for nonpracticed members (e.g., *Digress*) on later word fragment completion tests (Bajo et al., 2006). In this study, however, the pairs (e.g., *Di–Dilemma*) appeared in various colors and screen locations, so that incidental episodic features were encoded. Gómez-Ariza et al. (2012) ensured that Rp+ and Rp− items from a category appeared in different colors and locations, making these features distinctive. Crucially, participants did not recall the words on the test; instead, they received a color (e.g., *Blue*) and recalled where it had appeared. Strikingly, Gómez-Ariza et al. found that retrieval practice on *Di–Dil* (dilemma) impaired memory for where blue had appeared, if one of *Dilemma*'s competitors (e.g., *Digress*) had appeared in blue. This shows that suppression of *Digress* during retrieval practice of *Di–Dil*___ disrupted memory not just for the competing word but also for episodic attributes (location) tested from episodic probes (colors). Thus, episodic probes can reveal cue-independent forgetting.

Masking, however, can account for Perfect et al.'s (2004) data, a possibility consistent with features of their design. For example, in Experiments 1–2, participants studied each pair (*Fruit–Banana*) together with the face that was meant to serve as the independent probe. Simultaneously presenting the category and the face next to the exemplar would have fostered associations between the face and the category, undermining the face's value as an independent probe. When face cues appeared alone on the test, participants may have therefore accessed the categories to retrieve exemplars, especially for practiced categories. This may have been especially prevalent in Experiment 2, where retrieval practice was performed with both the face and the category, encouraging the searching of memory with both cues. When faces appeared alone at test, remembering the category that went along with them to search memory followed naturally.

Perfect et al.'s (2004) Experiment 3, however, used verbal independent probes trained in a separate phase, and so spatial/temporal proximity to the category at study does not apply. Notably, however, Experiment 3 used study–test cycles to train probe–exemplar associations (e.g., *Zinc–Apple*) before study of category–exemplar pairs. Given this repeated training, probes (e.g., *Zinc*) would likely come to mind while encoding category–exemplar pairs minutes later (*Fruit–Apple*). If probes (*Zinc*) were associated to categories (*Fruit*) this way, probes might have elicited the category at test, especially for practiced categories. Thus, Perfect et al.'s efforts to ensure the independence of independent probes may have achieved the opposite: associations between probes and categories. If so, masking may have obscured evidence for cue independence. Though speculative, this should be investigated to reconcile this discrepant finding with demonstrations of cue-independent forgetting.

Concluding Remarks

Cue independence is an important property of RIF favoring a role of inhibition. Despite many published examples of cue-independent forgetting, there have been instances in which RIF appeared to be cue dependent (e.g., Camp et al., 2007; Perfect et al., 2004). This led to the suggestion that RIF may be cue dependent in general, consistent with interference, and that reported cases of cue independence arise from hidden interference from covert cuing. We evaluated this by documenting how such cues affect recall on independent probe tests. We achieved this by simulating covert cuing with overt cues and by asking people to use covert cuing on an independent probe test.

Our findings show that covert cuing does not cause cue-independent forgetting. Indeed, far from causing it, covert cuing eliminates or even reverses this effect. These findings thus disconfirm core predictions of the self-inflicted blocking theory. At the same time, they reveal why RIF may at times be cue dependent: masking, due to covert cuing. If uncontrolled, covert cuing makes cue independence hard to observe (see M. C. Anderson, 2003, for safeguards that help avoid covert cuing). These findings thus serve as a cautionary tale documenting a potent factor to be monitored when using the independent probe method. The demonstrations of cue independence reported here reinforce that RIF is cue independent. That RIF exhibits cue independence is strong support for the role of inhibition in forgetting (M. C. Anderson, 2003; M. C. Anderson & Spellman, 1995; Levy & Anderson, 2002).

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Appendix

Materials for Experiments 1–3 (English Translations in Parentheses)

Category	Exemplars	Independent probe
	Rp−/Nrp-high items	
Ave (Bird)	Paloma (Dove)	Mensaje (Message)
	Búho (Owl)	Noche (Night)
	Gaviota (Seagull)	Acantilado (Cliff)
Fruta (Fruit)	Naranja (Orange)	Vodka (Vodka)
	Manzana (Apple)	Paraíso (Paradise)
	Cereza (Cherry)	Pachá (Pasha)
Juguete (Toys)	Muñeca (Doll)	Casita (Dollhouse)
	Pelota (Ball)	Portería (Goal)
	Cometa (Kite)	Viento (Wind)
Ropa (Clothes)	Chaqueta (Jacket)	Cazadora (Leather jacket)
	Falda (Skirt)	Escocia (Scotland)
	Pantalón (Trousers)	Pitillo (Slim pants)
Herramienta (Tools)	Sierra (Saw)	Dientes (Teeth)
	Clavo (Nail)	Cuadro (Picture)
	Hacha (Axe)	Tronco (Stem)
Vehículo (Vehicle)	Autobús (Bus)	Escolar (School)
	Bicicleta (bicycle)	Vuelta (Go-around)
	Camión (Truck)	Basura (Garbage)
	Rp−/Nrp-low items	
Ave (Bird)	Cisne (Swan)	Lago (Lake)
	Cotorra (Parrot)	Cotilla (Gossip)
	Ruiseñor (Nightingale)	Joselito
Fruta (Fruit)	Melón (Melon)	Jamón (Ham)
	Plátano (Banana)	Mono (Monkey)
	Fresa (Strawberry	Nata (Cream)
Juguete (Toys)	Puzzle (Puzzle)	Pieza (Piece)
	Trineo (Sledge)	Nieve (Snow)
	Yoyó (Yoyo)	Cuerda (Rope)
Ropa (Clothes)	Bikini (Bikini)	Toalla (Towel)
	Calcetín (Sock)	Pie (Foot)
	Pijama (Pyjamas)	Cama (Bed)
Herramienta (Tools)	Tenaza (Pliers)	Cangrejo (Crab)
	Afilador (Sharpener)	Piedra (Stone)
	Taladro (Drill)	Agujero (Hole)
Vehículo (Vehicle)	Moto (Motocycle)	Repartir (Deliver)
	Velero (Sailing ship)	Regata (Race boat)
	Hidroavión (Seaplane)	Amerizaje (Landing)

Received March 17, 2012
Revision received August 2, 2012
Accepted August 8, 2012 ■