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Inhibition in goal systems: A retrieval-induced forgetting account ☆

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Abstract

In social psychological models of goals, particular means or goals that receive more activation are pursued while their counterparts are "inhibited." To account for inhibition, these theories emphasize structural distribution of resources and the consequences of goal or means choices. Absent are alternate accounts of inhibition based on memory processes that rely on retrieval or recall of items. We propose that the act of recalling means or goals from memory entails inhibition of competing alternatives. Two experiments using repeated retrieval paradigms present evidence that recalling one means associated with a particular goal inhibits competing means. Moreover, this inhibitory mechanism is sensitive to the structural relationship of goals and means. Implications for models of inhibition in goal pursuit are discussed.
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Introduction

Memory processes are integral to goal pursuit. For example, if you have written a letter, you must actually remember to mail it on your way to work. Indeed, remembering one's goals or concrete actions to attain them when presented with a goal opportunity is the central question of research in prospective memory (e.g., Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998). Memory processes, however, may be important not just in remembering what you intended to do, but also forgetting those things you

do not currently want to do. For example, if one intended to mail a letter on one's way to work, it would be helpful if everything else one had to do once at work was momentarily forgotten. By not recalling other things, the likelihood that one will remember to mail the letter when passing the post office is enhanced. This "forgetting" or inhibition of potential distractions in the context of goals is the focus of this paper.

Extant models of goal inhibition

The importance of inhibition is well-recognized by researchers in motivation and goals. German will psychologists, for example, placed a heavy emphasis on the ability to counter the interference of competing action tendencies (e.g., Ach, 1935). They believed that successful goal pursuit required not only focus on the task at hand, but also ignoring all other possible pursuits. Protecting one's goal intentions from interference continues to be a mainstay in contemporary theories of goals (e.g., Gollwitzer, 1990; Kuhl & Beckman, 1985; Shah, Friedman, & Kruglanski,

2002). Moreover, the introduction of cognitive methods to the study of goals has allowed researchers to begin examining underlying mechanisms by which goals are shielded from interference.

Much of the social psychological work examining goal inhibition has been guided by goal systems theory. Proposed by Kruglanski and colleagues (2002), goals systems theory proposes that goals are cognitively represented as hierarchical structures. Goals and the subordinate means that serve them are connected in a network of associative links. Horizontal interconnections between goals and between means tend to be inhibitory (i.e., activation of one dampens the activation of the other), whereas vertical interconnections between goals and subordinate means tend to be facilitative (i.e., activation of one enhances the activation of the other). Importantly, goals systems theory assumes that there is a limited amount of resources that are distributed in this network of associations, and that these associations act as highways by which these resources are shared among goals and means. These basic assumptions about how goals and their subordinate means are represented as networks or systems provide the basis for two possible mechanisms for inhibition.

Resource diffusion

One mechanism for inhibition is through resource diffusion. The likelihood that any means will be used depends on the strength of association between the means and the goal. Goals systems theory suggests that because activation or energy is a limited resource in a goal network, the strength of association depends on the number of subordinate means associated with a given goal. Drawing from research on the fan effect (Anderson, 1983), goal systems theory proposes that if a goal has many means, there is less chance that any one will be chosen. That is, the strength of any one means will be proportional to the number of other means linked to the same goal. To illustrate, imagine a goal is associated with four means, and the total fixed activation state is 100%. If one means has been repeatedly selected or used more than the others and has thus developed a 70% chance of being activated, the remaining 30% of the activation will need to be evenly distributed among the other three means. This suggests that when that goal is activated, the 70% means is more likely to be selected or used over the other 10% means. Through structural portioning of activation, the less preferred means are relatively inhibited (or at least have less activation) than the most preferred means.

Resource diffusion as an inhibitory mechanism has received empirical support. In one study (as described by Kruglanski et al., 2002), participants were first asked to list an attribute (or goal) that they wanted to attain, such as "educated" and activities (or means) to attain that attribute, such as "study" or "read." These attributes and activities were then used as subliminal primes and targets, respectively, in a subsequent lexical decision task. Response times to activities primed with goals vs. control words were faster when participants listed fewer activities,

suggesting that the strength of the link of a goal to any one means is diminished in the face of multiple alternatives.

Goal-shielding

Whereas resource diffusion represents a passive mechanism of inhibition, goal-shielding proposes a more dynamic, active mechanism. Through experience, horizontal inhibitory links between means and goals develop such that the activation of one causes the de-activation of other competitors. Thus, if a student decides to pursue the goal to study rather than party, the activation of studying dampens the activation of partying through inhibitory associative connections, hence the term goal-shielding. Similarly, if people decide to drink beer rather than wine as a means to becoming inebriated, the activation of beer laterally inhibits the activation of wine. Through structural horizontal inhibitory links, the activation of one goal or means dampens the activation of competing goals or means.

As with resource diffusion accounts of inhibition, empirical findings have supported goal-shielding as a mechanism of inhibition. Shah et al. (2002) asked participants to list several activities that they intended to perform in the upcoming week (e.g., running, biking). Assuming that these activities are mutually exclusive and belong to the same goal network (i.e., they shared a superordinate goal such as exercising), they should compete for activation. To reduce this competition, Shah and colleagues reasoned that the activation of one should inhibit the others through horizontal inhibitory links. Supporting this suggestion, using a sequential priming paradigm, they demonstrated that accessibility of any one activity was dampened when primed with a competing activity.

Memory-based model of inhibition: retrieval-induced forgetting

Noticeably absent from extant models of inhibition in the social psychological study of goals is a treatment of memory-based processes that bear upon the retrieval or recall of attainment means. Models like goals systems theory draw largely from cognitive research on concept activation, which does not provide a full picture of the processes involved in memory for goals. This is striking, as remembering to pursue a particular goal or perform a particular means in the face of salient alternatives is a critical component of goal pursuit (e.g., Goschke & Kuhl, 1993; Marsh et al., 1998). As noted in the example earlier, people might intend to communicate with friends by writing a letter. Once the letter is written, they must remember to mail it and not get distracted by other concerns.

The relative lack of memory-based processes in social psychological models of goals is particularly unfortunate as inhibitory processes in memory have generated an extensive literature in cognitive psychology. In particular, research in retrieval-induced forgetting suggests an additional mechanism of inhibition that is distinct from

resource diffusion and goal-shielding accounts. A retrieval-induced forgetting perspective suggests that inhibition of alternate competing means is instrumental in the *selection*, or retrieval from memory, of particular means. By selection, memory researchers refer not to conscious decisions about what items to recall or between which items to choose, but rather to the cognitive processes (conscious or unconscious) that render the to-be-recalled item accessible and hence, more ready for conscious recall. Applied to goals, this memory perspective suggests that inhibition is neither merely a residual effect of multiple interconnections between means and goals (resource diffusion) nor a mechanism to prevent a current means from becoming derailed (goal-shielding). Rather, we inhibit to remember.

Often when one tries to recall an item from memory, there are competing items that come to mind. For example, when recalling the name of a specific dog breed, the first breeds that pop into mind may not be the one sought for but rather the ones seen most recently. There must be a way of countering this interference to isolate a particular item for prominence in recall. *Retrieval-induced forgetting* refers to a phenomenon in which repeated retrieval of a given item renders competing items less accessible for recall (e.g., Anderson, 2003; Anderson & Bell, 2001; Anderson, Bjork, & Bjork, 1994; Anderson, Greene, & Mc Culloch, 2000; Anderson & Mc Culloch, 1999; Anderson & Spellman, 1995). This account suggests that the act of recall engages inhibitory processes that ultimately lead one to forget competing alternatives. Through inhibitory processes, episodic traces are isolated and rendered relatively more active and easily recalled (e.g., Mayr, 2002; Neill, 1997). Thus, the act of remembering one item leads to forgetting others.

A successful method for exploring this mechanism has been the retrieval-practice paradigm. The standard paradigm (e.g., Anderson et al., 1994) begins with an encoding phase wherein participants see categories such as FRUITS and DOGS along with exemplars of each category. Each category–exemplar pair (e.g., DOGS COLLIE) is presented individually. During the presentation of each pair, participants are told to spend the time relating the exemplar to its category. In the subsequent retrieval-practice phase, participants repeatedly only see a subset of the exemplars from half of the categories in the following format: DOGS CO____. During each presentation, the participants' task is to type the entire word that they remember having seen in the experiment that fits the cue. After a filler task, category-cued free recall is given on all of the categories seen in the experiment.[1]

Typically, exemplars that receive retrieval-practice (hereafter Rp+ items) have higher rates of recall, $M = 74\%$, than the unpracticed members of that same category (hereafter Rp− items), $M = 38\%$. The unpracticed categories that were only presented in the encoding phase (hereafter Nrp items), serve as the baseline at chance levels of recall, $M = 49\%$. Thus, retrieval practice on certain exemplars within a category impairs the recall of the unpracticed members relative to the baseline ($49\% - 38\% = 11\%$ impairment). The measurement of inhibition is a key aspect of the paradigm: inhibition is defined in comparison to a true baseline, thus allowing for claims of inhibition rather than relatively less activation. Important to note is that research has demonstrated that retrieval-induced forgetting paradigms reveal true inhibition of targets rather than merely weakened associations between cues and targets (Anderson & Spellman, 1995). Impaired recall of inhibited targets remains even when novel associates are used as cues. Thus, inhibition in retrieval-induced forgetting cannot be explained by poor cue-target associations, but rather by the inhibition of the target beyond its normal activation baseline (see Levy & Anderson, 2002, for a detailed discussion). In sum, the patterns of impairment in retrieval-induced forgetting paradigms are well-established measures of memory-based inhibition.

The present studies

The present studies attempt to incorporate retrieval-induced forgetting processes into the social psychological study of goals. This account is distinct from extant models in that it adds an inhibitory mechanism during retrieval from memory. That is, the suppression of competing means aids in the selection or preferential activation of a particular means for recall. This suppression, in turn, leads to inhibition of the suppressed means.

Applying retrieval-induced forgetting to the study of goals not only provides a novel account of goal inhibition, but also provides empirical contributions as well. Previous studies have had to make assumptions about the structure of participants' goal networks based on self-report and patterns of response times (e.g., Fishbach, Friedman, & Kruglanski, 2003; Shah et al., 2002). For example, in the study described earlier (Shah et al., 2002), participant listed activities they intended to accomplish in the upcoming week (e.g., running, biking). The assumption was that these activities shared a superordinate goal (e.g., exercising) and thus competed for activation. While this is a reasonable assumption, it remained an untested inference. Retrieval practice paradigms, in contrast, allow for greater control of the structure of a particular goal network by having participants encode specific means-goals relationships. Moreover, studies supporting extant models measure inhibition by the strength of association between two concepts. For example, priming the goal to study relative to control words leads to reduced activation of the target goal to exercise (e.g., Shah et al., 2002). It is not clear, however, whether these effects result from true inhibition (i.e., "exercise" is less accessible *below* its baseline activation level) or from a weakened association between the two concepts (i.e., "exercise" is still active, but the association between

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[1] While in Anderson and Mc Culloch (1999) participants wrote down a single word, pretesting for the current study showed that 30 s provided ample time to type six means consisting of two words each. Hence, to keep in line with previous research, we kept the timing to 30 s.

"exercise" and "study" is reduced). Stated differently, it is impossible to know from spreading activation paradigms whether poorer performance reflects de-activation of nodes vs. weakened links between nodes. As described earlier, however, research has demonstrated that differences in cued recall performance in retrieval-induced forgetting paradigms are not attributable to weakened associations between cue and target, but rather actual suppression of the memory of target *itself* (Anderson & Spellman, 1995). Thus, if successful, these studies should be able to demonstrate true inhibition of means and goals rather than weakened associations in goal networks.

In two experiments, we sought to determine whether retrieval-induced forgetting provides a possible mechanism for goal inhibition. Experiment 1 addressed whether standard retrieval-induced forgetting effects can occur in the context of goal networks. That is, we wanted to see if repeated selection of a subset of means (e.g., Write Resume, Phone Employers, Practice Interview) from a particular goal (e.g., Finding a Job) led to impairment in recall of other means belonging to the same goal. Experiment 2 replicated these results and explored facilitative relations between goals as a moderating factor. A functional goals system should inhibit only competing goals and means, rather than those that share facilitative relationships. Together, these experiments are designed to demonstrate both the viability and functionality of a retrieval-induced forgetting mechanism for goal inhibition.

Experiment 1: forgetting the means

This study was designed to demonstrate retrieval-induced forgetting in the goal context. Since people often try to recall means for pending goals, it is of interest whether repeatedly retrieving one way of accomplishing a particular goal leads to the neglect of other perfectly good means. Using a modified retrieval-practice paradigm (e.g., Anderson et al., 1994), Experiment 1 tested whether repeated retrieval of a subset of means from a particular goal led to impairment in recalling other means. Participants were asked to imagine performing means belonging to particular goals. They were then asked to repeatedly retrieve a subset of those means. A goal-cued free recall test was used to probe for memory of their associated means. We predicted that to isolate certain means to goals for selection and retrieval, competing means would be suppressed. Recall for these competing means should fall below baseline (non-practiced means from a non-practiced goal) demonstrating inhibition.

Method

Participants

Sixty New York University undergraduate students participated in this experiment for partial fulfillment of course requirements.

Materials

All materials for Experiments 1 and 2 were developed from social psychology student responses. Twenty students were asked to generate means to given goals. We purposely chose goals that many students would already hold and some that they might not. For instance, Finding a Job and Organizing a Party might be common goals for students in New York City, but Treating a Patient and Setting up Camp would be less common. Goals and means are often structured for us (see Forster, Liberman, & Higgins, 2005) and this aspect of goal knowledge is taken into account in this experiment.

Critical means were chosen from a compilation of the means generated by students and from websites devoted to these goals (e.g., How to Find a Job) with the following constraints. Each critical means had to consist of two words that denote a particular action, such as Practice Interview, Update Chart, Gather Firewood. To prevent item confusion, the verb of each means phrase had a unique letter-stem (e.g., "practice" was the only verb that began with "pr"). Repetition of the letter-stems of the means phrase's second word across the goals was limited. The average versatility of the letter-stems for each goal's means fell between 300 and 355 (Solso & Juel, 1980). Means were chosen that were concrete and imaginable (e.g., Pitch Tent, Write Invitations, Change Bandages) and had no distinct temporal order within each goal. Temporal order (e.g., how to make a cup of coffee) of means may afford an embedded retrieval structure which would likely attenuate inhibition effects (Anderson & Mc Culloch, 1999).

Fifteen participants then rated on a 10-point scale how well they thought that the means fit or helped attain the goals. Means or goals with an average utility rating below 5 were dropped. From this, we obtained four critical goals and two filler goals with six means each. For counterbalancing and retrieval-practice purposes, goals were divided into two sets and each goal's means were divided into two subsets yielding four sets total.

Design

Retrieval-practice was manipulated within subjects with three levels: means that received retrieval practice (Rp+), means that did not receive retrieval practice (Rp−) but the other means connected to that goal did, and means from goals that were only seen in the study phase of the experiment (Nrp). These Nrp means both did not receive retrieval practice and were not linked to a goal that had means that were practiced.

Procedure

Participants were first given a sheet listing all of the goals with their respective sets of means. They were asked to rate on a 10-point scale how well they thought that each individual means fit or achieved its goal. This means utility rating task served as a preliminary encoding phase. Next,

participants engaged in the four following phases adapted from the standard retrieval practice paradigm.

Imagine phase. Participants were told that they would be doing a computer task where they would be seeing goal-means pairs (i.e., a goal paired with a means used to fulfill that goal: Finding a Job Practice Interview) presented individually for 9 s each. In standard retrieval practice paradigms, participants are asked to spend this time elaboratively encoding the relationship between exemplars and their respective category. To mimic this process in a more realistic context of goals, participants were asked to spend the entire 9 s imagining performing the means to attain the goal. Imagining performing goal means in this way parallels mental simulation processes people spontaneously engage in during means selection and planning (e.g., Taylor, Pham, Rivkin, & Armor, 1998). All 6 goals were paired with each of their 6 means in a block-randomized order, yielding 36 trials.

Retrieval-practice phase. After all goal-means pairs were presented, participants were instructed that they would be given cues to help them retrieve a particular means or action they had imagined performing in the previous phase. On the screen, a goal appeared together with the first two letters of each word in the particular means or action that was seen or imagined performing earlier in the experiment (e.g., Finding a Job Pr___ In___). Their task was to fill in the blanks by recalling the means that they imagined performing in the previous phase that fit the cue. They were given 7 s to type in the means phrase (e.g., Practice Interview).

Participants saw half of the critical goals, either Set 1 or Set 2, and practiced either Subset A or B of the means. Hence, each participant practiced half of the means from each of the 2 critical goals. Filler goals and means were used in this phase to enable the use of an expanding schedule format (Anderson & Spellman, 1995) for a total of 40 trials. In an expanding schedule, the repetitions of a practice pair (e.g., Finding a Job Pr___ In___) are spaced apart in increasing intervals to ensure optimal processing through distributed practice.

Test phase. After a 10-min distracter task, a goal-cued recall test was administered for the means for all goals presented in the study phase. Four test orders were used, rotating goal positions. Participants saw each goal presented on the computer screen with a text box underneath and were asked to list all of the means they remember having imagined performing or seen in this experiment. Participants were told that they had 30 s to type their responses for each goal cue (Anderson & Mc Culloch, 1999).[1]

Results and discussion

A repeated measures ANOVA was run on the three levels of recall, Rp+, Rp− and Nrp, revealing a significant main effect of recall, $F(2, 118) = 82.38$, $p < .001$.[2] To assess facilitation and inhibition, respectively, we compared the percentage of correctly recalled Rp+ items ($M = 85\%$) and Rp− items ($M = 48\%$) to the recall of Nrp items ($M = 63\%$). Simple contrasts revealed repeated retrieval of a subset of means led to significantly better recall, above baseline, for those means, $F(1, 59) = 131.87$, $p < .001$. Moreover, repeated retrieval of these means led to significantly impaired recall, below baseline, of other means belonging to the same goal, $F(1, 59) = 23.84$, $p < .001$. These findings suggest that retrieval-induced forgetting is a viable account for goal inhibition. That is, retrieving a particular means is facilitated by inhibitory processes that resolve interference from other competing means.

Researchers of goal inhibition have noted that although inhibition of competing goals or means can be functional, ubiquitous inhibition is not (e.g., Fishbach et al., 2003; Shah et al., 2002). For example, it is insensible to inhibit one goal or means if it helps facilitate the accomplishment of another. Thus, when goals or means have facilitative relationships, it makes more sense to boost the activation of one given the other so that they can mutually benefit one another. Indeed, previous research has demonstrated that goal inhibition is sensitive to such relationships (e.g., Shah et al., 2002).

Experiment 2 was designed to replicate the results of Experiment 1, and provide evidence that a retrieval-induced forgetting mechanism of goal inhibition is sensitive to facilitative relationships between goals and means. That is, retrieval-induced forgetting is functional only when means compete for recall (within the same goal). Distinct means from a second associated goal not only do not compete, but may even promote recall of a particular target means by serving as an additional cue. Thus, retrieval-induced forgetting should be apparent only when there is the potential for interference (recalling a specific goal-means pairing). When two goals with distinct means are facilitatively associated, however, recall of one goal-means pairing should facilitate rather than inhibit the recall of the other. In Study 2, we tested this by presenting participants not only with the materials in Study 1, but also with goals that shared an over-arching superordinate goal. We expected that when goals shared a facilitative link through a superordinate goal, we would see evidence of facilitation rather than inhibition of unpracticed means associated with related goals. However, we still expected retrieval-induced forgetting when this facilitative relationship between goals did not exist and the means directly competed for recall.

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[2] There were no significant differences between levels of recall for the common goals (Organizing a Party, Finding a Job) and less common goals (Treating a Patient, Setting up Camp), and thus we collapsed over these two groups of goals for the critical analyses.

Experiment 2: inhibitory patterns in related goals

Method

Participants

Forty-five New York University undergraduate students participated in this experiment for partial fulfillment of course requirements.

Materials and procedures

Materials and procedures for this study were identical to Study 1 except that in this experiment, a factor of facilitative relatedness was included such that two of the four goals were goals related through an overarching goal. The goal "Treating a Patient" was paired with "Preparing a Patient for a Visit," both which share the overarching goal of "Taking Care of Patient." However, the means belonging to each goal were distinct; that is, the means belonging to one goal would not satisfy the other related goal and the only relation between the means is the over-arching goal (see Fig. 1). For instance, the goal "Preparing Patient for a Visit" had means such as Comb Hair, Help Dress, Brush Teeth, whereas the goal "Treating a Patient" had means such as Update Chart, Disinfect Wound, Give Pills. To instill the structure of the goal hierarchy, the over-arching goal, "Taking Care of a Patient" was referenced twice in the directions for the "utility" ratings task at the beginning of the experimental session. We asked participants to adopt the perspective of a nurse in evaluating the utility of these goals and when imagining performing the means of these goals. The other goals used were two of the unrelated goals in Experiment 1 ("Finding a Job" and "Setting Up Camp").

To set up appropriate baseline comparisons, in contrast to Experiment 1, two retrieval-practice conditions were manipulated between subjects. Retrieval-practice condition 1 consisted of participants engaging in retrieval practice on

means belonging to one of the goals in the related goal pair and on means from one of unrelated goals. Here, one related goal and one unrelated goal served as the baseline (see Fig. 2a). In retrieval-practice condition 2, participants engaged in retrieval practice on both unrelated goals, with the two related goals serving as the baseline (see Fig. 2b). These two conditions were designed to capture the effect that practicing means from one related goal might have on the recall of means from a related goal that was not practiced. [3] To assess this, a true baseline was needed, which was derived from condition 2. In condition 2, neither related goal is practiced, only learned. Therefore, this condition serves as a baseline for each related goal free of possible practice effects, in comparison to condition 1 (Anderson & Spellman, 1995). In other words, the true baseline reflects the general *memorability* of a goal and its means.

Results and discussion

A 2 (retrieval-practice conditions: 1 vs. 2) × 3 (levels of recall: Rp+ vs. Rp− vs. Nrp) mixed ANOVA with repeated measures on the second factor was run on percentage of items recalled. As expected, there was a significant main effect of recall, $F(2, 94) = 120.31$, $p < .001$ (see Table 1 for means). Across both retrieval practice conditions, there was evidence of both facilitation of practiced means ($M = 26.5\%$), $F(1, 48) = 171.08$, $p < .001$, and inhibition of unpracticed means ($M = 10.3\%$), $F(1, 48) = 17.00$, $p < .001$. To replicate specifically the findings of Experiment 1, we ran simple contrasts using only the unrelated goals, such that all items, Rp+, Rp− and Nrp, were from the goals "Finding a Job" or "Setting up Camp." Again, we found facilitation of practiced means ($M = 25\%$), $F(1, 23) = 36.53$, $p < .001$ and inhibition of unpracticed means ($M = 17\%$), $F(1, 23) = 9.86$, $p < .01$. Thus, these data replicate the results of Experiment 1, suggesting that retrieval-induced forgetting can be applied to the study of goal inhibition. That is, the preferential activation, or isolation, of a particular means for recall is made possible by processes that resolve interference from other means, rendering these means inhibited.

As mentioned earlier, ubiquitous inhibition, however, is not functional in all situations. This is particularly true when goals share a facilitative relationship. In such situations, it makes more sense to boost the activation of one given the other as they might serve as recall cues for each other. We modeled this facilitative relationship between goals in this study by providing a condition in which two goals shared an overarching goal. To test whether retrieval practice of the means of one goal facilitated or inhibited the
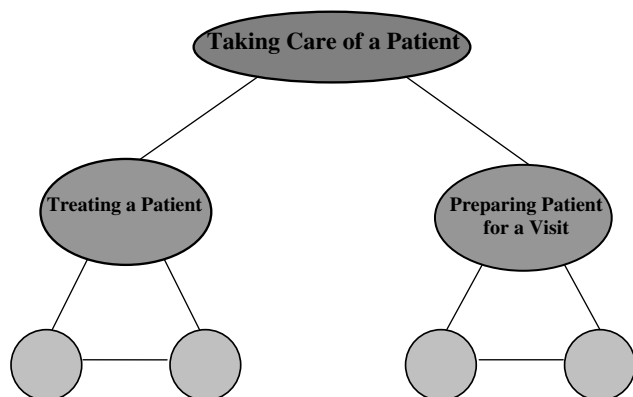

Fig. 1. The superordinate or overarching goal, Taking Care of a Patient, with the two mid-level goals, Treating a Patient, and Preparing Patient for a Visit. The nodes underneath the mid-level goals depict the means used to fulfill the goals. Note that means are distinct to the goals that they serve, thus the means are not multifinal (do not apply to more than one goal in this experiment).

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[3] We note that a fuller design of this experiment would have included a condition where means from both related goals were practiced. Although we did not have clear predictions about the outcome of such a condition, it would have been interesting from exploratory perspective. However, as it did not directly test our focal hypotheses, we chose to limit our design.

a   Experiment 2

Retrieval Practice Conditions.

1. Practice 1 Related Goal & 1 Unrelated Goal
= Rp+ & Rp-items

b   Experiment 2

Retrieval Practice Conditions.
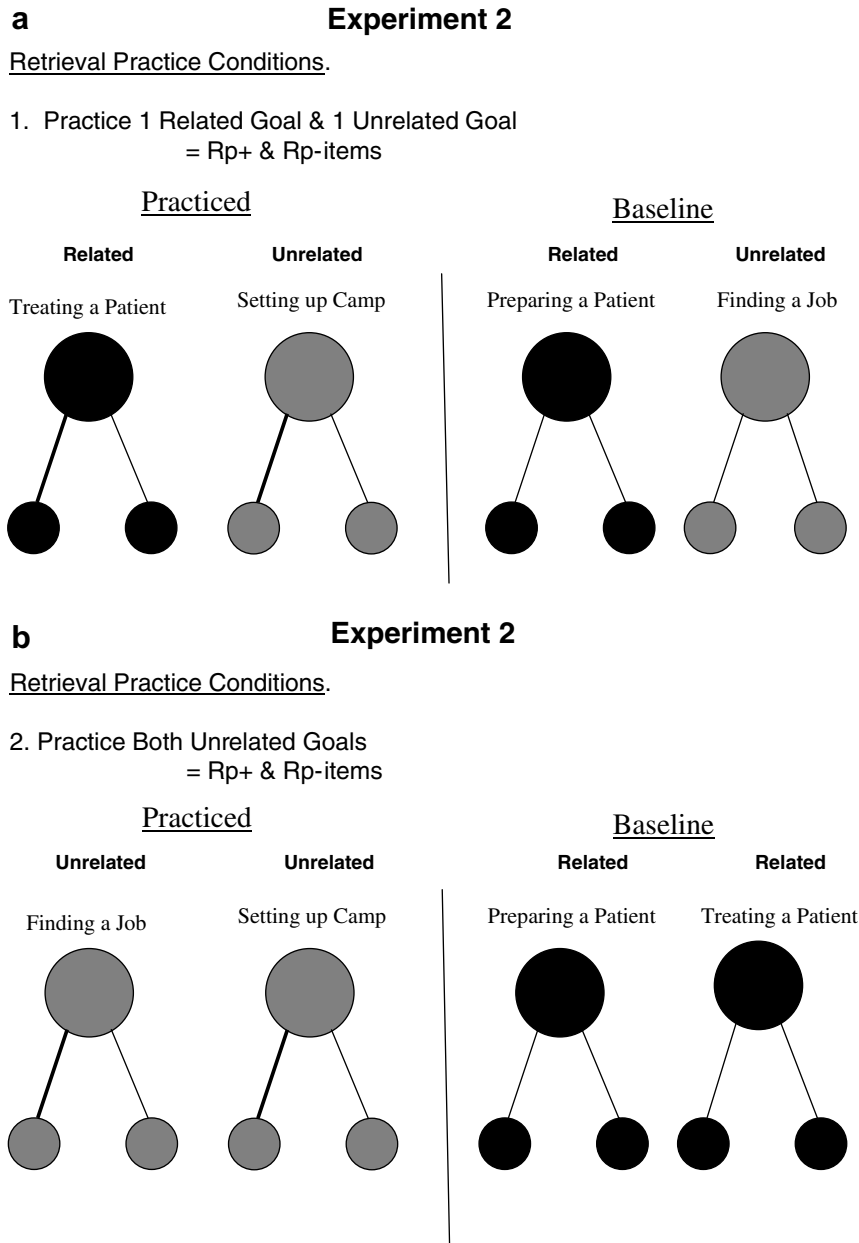
2. Practice Both Unrelated Goals
= Rp+ & Rp-items

Fig. 2. (a) Relatedness manipulation for the retrieval practice phase. Condition 1 was designed to assess the effect of practice of a goal on its unpracticed related goal. Bold lines in "Practiced" indicate the subset of means practiced. (b) The "true baseline" for related goals. Condition 2 was designed to give a recall measure for the related goals free from the effects of practice of one of either related goals upon the other.

Table 1
Experiment 2 results

	Rp+	Rp−	Baseline (NRP)	
Mean percent recall				
Overall	90 (SD = .64)	53 (1.179)	63.27 (.90)	
Unrelated goals	96 (SD = .113)	54 (.323)	71 (.165)	
			Related baseline	True baseline
Related goals	88 (SD = .487)	54 (.783)	67 (.657)	57.79 (.395)

means of the other, we compared recall of related unpracticed means (in retrieval practice condition 1) to recall of unrelated unpracticed means (baseline of retrieval-practice condition 1). As expected, the recall of related ($M = 67\%$) vs. ($M = 57.79\%$) unrelated unpracticed means was elevated, $F(1, 94) = 3.38$, $p = .07$. This result, while marginal,

suggests that retrieval practice of the means of one goal facilitated, rather than inhibited, means of a facilitatively related goal. In sum, these data suggest that retrieval induced forgetting is functional and sensitive to the relationships between goals.

General discussion

The present research builds on extant social psychological research on goal inhibition processes by incorporating an important model of inhibition from memory research. Current models of goal inhibition (resource diffusion and goal-shielding) suggest that inhibition occurs as a function of the how goal systems are structured (e.g., Kruglanski et al., 2002). In contrast, we propose a mechanism whereby the act of retrieving a given means from memory initiates forgetting of alternatives. That is, to recall one means, others need to be inhibited. Consistent with this proposal, Experiments 1 and 2 demonstrated that frequent recall of one means leads to forgetting of competing means of the same goal.

Study 2 also demonstrated that retrieval-induced forgetting is sensitive to the relationships between goals. Rather than ubiquitously inhibit all non-selected goals and means, retrieval-induced forgetting only inhibits means that interfere with the recall of a particular goal-means pairing. When the recall of a particular means of one goal might be facilitated by the activation of related goals, we would expect to find facilitation rather than inhibition. This prediction was confirmed in Study 2. Retrieval practice led to inhibition of interfering means, but facilitated recall of unpracticed means of an associated goal. Thus, retrieval-induced forgetting is functional and sensitive to goal inter-relations.

In addition to demonstrating retrieval-induced forgetting as a mechanism of goal inhibition (as well as facilitation when functional), these studies make two important empirical contributions. First, these studies introduce a paradigm whereby experimenters can specify the structure of a particular goal network. As noted earlier, previous studies have had to infer the structure of participants' goal networks from self-reports and patterns of response times (e.g., Fishbach et al., 2003; Shah et al., 2002). Although this is a reasonable practice, it is possible to have greater control of the goal networks to be tested by using paradigms in which participants encode specific relationships between means and goals. Second, to date, research supporting extant accounts of inhibition has measured inhibition using strength of association measures (e.g., Fishbach et al., 2003; Shah et al., 2002). For example, when priming one goal (vs. control word) reduces the activation of a target goal, this is interpreted as inhibition. However, as argued earlier, these measures leave open the possibility that this apparent inhibition occurs due to weakened associations between prime and target rather than reduced activation of the target. Cued recall performance in retrieval-induced forgetting paradigms, in contrast, has been shown to result from true inhibition of targets and not

weakened associations (Anderson & Spellman, 1995). Demonstrating goal inhibition using retrieval-induced forgetting paradigms thus provide the strongest evidence that we are aware of to date that people do indeed inhibit competing goals and means.

One may ask, however, if the inhibitory mechanism explored in this paper can account for inhibition at the level of goals as well as the level of means. There is no reason to suspect that it would not if indeed the selection takes place between two competing goals that subserve an even higher level goal. If conflict occurs, the resulting interference would need to be resolved at any level of a goal hierarchy. Similarly, one may ask if different goal-means configurations would yield different results. As shown in Experiment 2, inhibition appears sensitive to relationships between goals precisely because different relationships engender different patterns of interference. Another topic that awaits further examination is whether inhibition exists in other goal configurations, such as multifinal means serving multiple goals (Kruglanski et al., 2002).

Paralleling recent work challenging research on associative models of forgetting (for reviews see Anderson, 2003; Anderson & Levy, 2007), the present findings suggest that goal inhibition may occur not only as a function of changing cognitive structure (Kruglanski et al., 2002), but also may occur during selective retrieval. Future work in both memory and goals research is needed to determine which account has greater explanatory value. It is important to note, however, that the present perspective does not repudiate or undermine all situations in which structural accounts such as resource diffusion or goal-shielding serve as mechanisms of goal inhibition. Rather, the present account is most relevant to situations in which memory processes are recruited in self-regulation, such as when remembering to execute pre-planned actions or when first implementing a new means to replace an older one. In the first case, having to remember specific plans might lead to the inability to remember alternative plans. In the second case, retrieval of a new desired means to attain a goal may cause inhibited access to old ones, as the old means may interfere as a result of their association with the goal. In situations where one need not recruit memory processes, however, a retrieval-induced forgetting account is yet silent. Thus, at this juncture, the two approaches can be best viewed as complementary, dovetailing to account for goal inhibition across a range of situations.

One intriguing possibility, however, is that retrieval-induced forgetting is an antecedent process to structural inhibition. That is, perhaps repeated retrieval of goal-related constructs (such as means) represents a mechanism by which horizontal inhibitory links between these constructs in goal networks develop over time (see also Danner, Aarts, & De Vries, 2007). Once established, memory-based processes may be less necessary or required in goal networks. Future research is clearly warranted to address how the two mechanisms interact and potentially influence one another.

Conclusion

To explicate the role of memory processes in goals and goal pursuit, we have proposed retrieval-induced forgetting as mechanism of inhibition. That is, the act of recalling a particular means or goal entails the inhibition of alternative and competing means and goals. This research suggests inhibition processes yet unexplored by extant goal theories. Understanding inhibitory processes in the context of goals is essential, given the myriad of problems people have in accomplishing their goals. Integrating the present approach to inhibition with extant theories suggests new possibilities for the cognitive study of motivation.

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