Opportunism in Memory: Preparing for Chance Encounters

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Abstract

Recognizing opportunities to achieve pending goals is an important cognitive ability. But when and how do we recognize that a current situation is especially suited to resuming a past goal? The *predictive encoding* model suggests pending goals are encoded into memory in association with anticipated environmental features. Optimally, these features are (a) necessary for successful goal satisfaction, (b) distinctive preconditions for expecting a plan to achieve the goal, and (c) described so as to be readily identified in the environment. Later, ordinary perception of features in the environment leads to automatic recognition of opportunities already prepared in memory. Evidence from experimental studies supports this theory, and demonstrates that general preparation can produce apparently novel opportunism. These findings suggest ways to facilitate the recognition of opportunities to satisfy pending goals.

Keywords

prospective memory; planning; opportunism; encoding; retrieval

In a dynamic world, people are sometimes forced to postpone pursuit of their goals. For some goals, a plan can be created, but a needed resource (e.g., time, location, or tools) may be currently unavailable. Because many goals are pursued simultaneously in everyday life, such intentions to return to pending goals are generated frequently. At the same time, people are continually confronted with rich environments containing potential connections to their goals. What determines whether someone recognizes an opportunity to satisfy a pending goal?

This problem of opportunism would seem to require elaborate reasoning: How else can someone identify one of many pending goals that is particularly relevant in the current environment? For example, suppose you have recently moved to a new home and need to change your address at the motor vehicle bureau. You make a mental note of your intention to go to the bureau office and fill out the required forms. But when, if ever, will you return to this pending goal? You may fail to do so, or you may adopt a strategy like creating an external reminder (e.g., a note on your calendar; cf. Ceci & Bronfenbrenner, 1985). But suppose, days later, you drive downtown for a scheduled lunch appointment and find it has been unexpectedly canceled, so that you have some free time before your next appointment. Will you recognize this circumstance as a good time to pursue the goal of changing your address? The ability to notice this event as an opportunity, and to shift your planning strategies accordingly, may be considered a hallmark of intelligent goal pursuit (Schank & Abelson, 1977).

MODELS OF OPPORTUNISM

Ideally, one would recall a goal from memory whenever the needed resources become available, and not otherwise. This would require that each new cue be compared with all pending goals in memory. To accomplish this, an early computational model of opportunism in planning (Hayes-Roth & Hayes-Roth, 1979) posited specialized goal agents that operate in parallel outside of conscious processes. According to this model, these agents watch for and "notice" conditions relevant to them, and then jump in to interrupt current processing to satisfy their goal. Their specific expertise (about conditions for specific plans, or how to cluster goals) gives the agents the ability to recognize whether novel circumstances are relevant to them.

Birnbaum and Collins (1984) argued that goals themselves can monitor information about their relevance to the current situation. For example, suppose you are both hungry and thirsty, and you decide to go out to a restaurant. If you pass a water fountain along the way, you will likely recognize it as an opportunity to satisfy your thirst ahead of schedule. This suggests some process must constantly reason about the relevance of new information (the water fountain), and insert its goal into current actions (stop for a drink). In fact, Freud (1935) suggested this same account to explain slips of the tongue, in which unexpressed goals interrupt and insert themselves into planned speech acts (as when a longtime bachelor asked, "How long have you been *buried*?" when he meant to say, "*married*"). However, if goals themselves have these capabilities, no opportunities would ever be missed.

A simpler alternative handles the problem of connecting later cues to goals in memory by noticing these connections at the time of memory encoding. If a pending goal has already been associated with a specific cue, the later presence of the cue in the environment automatically brings the goal to mind (this is

what is called event-based retrieval; Brandimonte & Passolunghi, 1994). For example, you may be reminded that you need to change your address when you happen to drive by the motor vehicle bureau, or when a family member mentions his or her own need to register. More specific cues have been found to work better than more general ones for event-based retrieval; for example, a person filling out a questionnaire will find it easier to remember to perform a future task if told to do so after finishing "the Black Panthers question" than after finishing "the last survey question" (Loftus, 1971). McDaniel, Robinson-Riegler, and Einstein (1998) have shown that perceiving a cue as related to a goal may depend on the current context; for example, studying the word "barn" as a cue may not result in retrieval when a farmyard scene including a barn is presented. In their studies, cues were assigned to goals at random (e.g., "perform action X when you see cue Y"); in more naturalistic tasks, cues have functional relationships to goals, and opportunism may require identifying the relationship of novel cues to pending goals.

PREDICTIVE ENCODING OF PENDING GOALS

Our own model further develops the idea of event-based retrieval to suggest how the types of features considered during encoding determine success in recognizing later opportunities (Seifert et al., 1994). In our account, the same planning processes that first recommend postponing further pursuit of a goal also predict which features may help to satisfy the goal. First, a plan is created, and special resources, tools, locations, agents, skills, or times required are identified. For example, changing your address at the motor vehicle bureau requires being downtown at the bureau office, having several hours free, having your current license with you, and being there during office hours. Once these features have been "prepared" in memory together with the pending goal, you are ready to notice related opportunities on the basis of external cues in the environment. This *predictive encoding* process involves the following steps:

1. A goal that cannot be fit into current activity is postponed.
2. The planner reasons about the circumstances required for its satisfaction.
3. The postponed goal is then encoded into memory in association with these features.
4. During other activities, the predicted features may be perceived in the environment.
5. When these features are perceived, the goal associated with them is also brought to mind.
6. The planner can then reason about whether to resume pursuit of the pending goal.

The success of this approach depends on the ability to predict which features are distinctive in successful goal pursuit. For example, having your current ID with you is a necessary precondition for changing your address at the motor vehicle bureau, but having your ID is not an indication of a particularly fortuitous time to resume pursuit of this goal. The more you can anticipate circumstances predictive of successful goal pursuit, the better you will be at noticing true opportunities when they occur.

EVIDENCE FOR PREDICTIVE ENCODING

In a series of studies, we investigated whether the predictive encoding model successfully accounts for the recognition of opportunities (Patalano & Seifert, 1997; Patalano, Seifert, & Hammond, 1993). Our participants engaged in a commonsense planning task with multiple goals, and then were given a cued-recall test of memory for the goals. Specifically, we tested the hypothesis that recognition of opportunities to achieve goals is enhanced if those opportunities are anticipated during encoding. The method involved a planning scenario familiar to the college students who were our participants:

> Imagine you are visiting your friend, Chris, in her dormitory room. A neighbor summons Chris to attend a hall meeting, and she leaves you alone in her room. You decide to snoop around the room, and if you're careful to leave no signs, she'll never find out.

Within this scenario, we presented a series of goals constrained by common objects, for example:

- You notice that Chris left her new college ring on her bureau. You try it on your finger, and it gets stuck. You need to get the ring off before Chris returns.
- You jump on the bed. In the process, you manage to leave scuff marks high up on the white wall next to the bed. You need to remove the scuff marks before Chris returns.
- When you open the window to get some fresh air, a breeze blows her poster off the wall. You are not sure how it was attached to the wall, but you need to reattach it before Chris returns.

During an initial study phase, participants were told to read and make a mental note of each goal. In addition, we manipulated the type of preparation performed during encoding of the goals. Participants in one group were given an object with the goal, and were asked to generate their own plan using that object; for example, for the "stuck ring" goal, they saw the cue, "You

think that if only you had some Vaseline, you might be able to ___?" A second group was given both a plan and an object for each goal; for example, they were told, "You think that if only you had some Vaseline, you might be able to grease your finger and slide the ring off." These instructional manipulations were intended to create differences in how participants encoded the goals into memory.

Next, a recall test presented a series of cues, and the participants were asked to write down any of the studied goals that "came to mind." Each cue described a single everyday object (e.g., "The only thing you find under the sink is a jar of Vaseline. If you could use the Vaseline to achieve any of your goals, record it below."). The cue presented could "match" what was studied during encoding (e.g., "lubrication with Vaseline" or "Vaseline") or present a novel opportunity (an object involved in an equally plausible plan, but not studied; e.g., "ice cubes" as a cue for the plan to "shrink your finger with cold ice to remove the ring"). In addition, each participant saw five filler cues that were less readily associated with any of the goals (e.g., "a comb," "tea bags," "a shoe"). The dependent measure was the percentage of goals recalled from the cue (e.g., "Vaseline") when it was anticipated (the participant saw "Vaseline" during planning) or unanticipated (but related; the participant saw "ice cubes" during planning).

As expected, more goals were recalled in response to anticipated cues: If "Vaseline" was studied with the goal of removing the stuck ring, participants recalled the "stuck ring" goal given the "Vaseline" cue. Participants who studied "ice cubes" with the "stuck ring" goal were less likely to see the goal as related to the "Vaseline" retrieval cue. Unless prepared for the specific opportunity, participants did not connect the later cue to its relevant goal in memory. All participants had plenty of time to consider the cue object and recognize that it could be helpful for the goal. However, those who anticipated the cue were more likely to report it as an opportunity than those who did not anticipate it.

Must you anticipate exactly the object later seen as a cue in order to recognize it as an opportunity? In other studies, we found that anticipating the plan helped people recognize novel objects as opportunities; for example, both "Vaseline" and "butter" facilitated recall for participants who had prepared the "lubrication with Vaseline" plan for the "stuck ring" goal. The advantage of predictive encoding is ready recognition of not just the specific objects anticipated, but also other objects that fit the plan. In sum, the advantages in retrieval observed were specific to the type of plan predicted, but not to the specific object anticipated with each plan. These results support the hypothesis that predictive encoding of cue features can improve the likelihood of noticing later opportunities.

CONCLUSIONS

These experimental findings support the predictive encoding model, in which planning features are predicted at the time of goal postponement, indexed with the goal in memory, and later brought to mind by cues experienced in the environment. Although McDaniel et al. (1998) showed cue associations at the time of encoding can lead to successful retrieval, the present findings show opportunism can also be based on novel cues not present during encoding. They also go beyond the results of Tulving and Thomson (1973), who demonstrated that recall is facilitated by similarity in encoding and retrieval cues, because we found that functional similarities play a key role in opportunistic remindings (e.g., "Vaseline" and "soap" share a functional role in the plan of lubricating the finger with the stuck ring). Predictive encoding suggests that the planner must create functional associations with possible plans in advance in order to later recognize specific objects as opportunities for goal satisfaction.

A further challenge for this theory is to explain exactly what constitutes a predictive feature. What level of description is best for predicting opportunities within a domain? For example, with the "address change" goal, you might anticipate location, as in "Next time I'm in the vicinity of the motor vehicle bureau, I'll change my address." However, this specific opportunity may not arise for some time. At the other extreme, prepared features may be too general, as in the plan "Next time I have free time, I'll change my address." This feature may occur more often, but noticing it may be more difficult. Optimally, predicted features are (a) necessary circumstances for satisfying the goal, (b) selected as distinctive conditions for executing a plan, and (c) formulated so as to be readily identified in the environment. For example, anticipating a canceled appointment as just the circumstance needed for you to pursue the goal of changing your address would maximize your chance of recognizing this type of opportunity.

The ability to generate descriptions of predictive features may improve with experience within a domain. With experience, a "planning vocabulary" of available resources and critical constraints may be identified, leading to better anticipation of features that indicate opportunities. We expect individuals to vary in their success at recognizing opportunities, to improve with experience within a domain, and to be limited by the quality of their planning (cf. Einstein & McDaniel,

1990). Predictive encoding requires high quality in plan preparation. If planning is successful, the impetus to return to postponed goals will arise automatically from features in the environment; but if planning is not successful, one may fail to return to pending goals, and will miss opportunities that occur. And with many goals active at any given time, the choice of which actions to pursue next may be largely directed by the events one experiences in the world (Gollwitzer, 1999; Marsh, Hicks, & Landau, 1998). Responding based on observed features may be especially advantageous in fast-paced, dynamic environments.

Predictive encoding is an important phenomenon because it ties the intelligent pursuit of goals to one's advance preparation. However, in some environments, it is not possible to stop and plan ahead while in the midst of other activities. In addition, predictive encoding may be costly when the effort expended in advance planning later proves unnecessary. For some less important goals, returning at a later time may not warrant the cost of preparation; for others, opportunities may be so readily available, or well learned, that predictive encoding is unnecessary. But in the appropriate circumstances, predictive encoding may represent a means of accomplishing intelligent planning within dynamic environments. Of course, we all miss some opportunities despite our efforts to prepare for them; however, through predictive encoding, we can maximize the detection of those opportunities we expect are most likely to arise. And to the extent that we can plan ahead to accomplish our goals in the world, chance encounters will favor our plans.

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Note

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