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A rational choice model of the biased recall of information

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ABSTRACT

This study introduces a rational choice model for a behavioral phenomenon known as differential retrievability, or biased recall. The phenomenon is characterized by the fact that individuals are more likely to recall information which is consistent with their initial preference, expectation, or belief. The model endogenizes the recall of information and ascribes utility functions to agents who must allocate scarce memory resources to pieces of information that are relevant to a future decision. While the biased recall of information was a detriment to groups in a group decision paradigm known as the hidden profile problem, this work shows that this is due to the discrepancy between the subjects' priors and the skewed information structure they were presented. A second model finds the optimal bias in information recall for a single decision maker who must use information from two distinct times to make a policy decision.

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1. Introduction

For the majority of decisions, information, rather than opinion, is the most valuable decision aid. Talented decision makers (DM) therefore seek to improve the quality of their decisions by improving the quality of the information made available to them. In the extreme case where an objectively optimal choice exists, a DM would like to obtain enough information so as to ensure the best choice is made. However, given sufficiently complex choice alternatives, such an abundance of readily available information is rare.

In reality, complicated decisions often involve information that must be gathered over time. Therefore, some previously acquired information which is relevant to a current decision must be summarized and reiterated to the DM, or equivalently, recalled by the DM. While technology exists to store and later retrieve a great deal of information, in this paper I am concerned with information which cannot easily be summarized, entered into a spreadsheet, and analyzed. Rather, I am concerned with information, which may be subjective, and must be recalled from memory.[1]

Psychologists have extensively studied the process by which humans recall information from memory and have determined numerous factors which affect the probability that a given piece of information is recalled.[2] The vast majority of these factors are exogenous, leaving little possibility for an individual to endogenously determine the probability that information is recalled. However, experimental evidence along with a strong intuitive argument suggests that, via rehearsal – in other words, the controlled repetition of the active cognition of certain pieces of information – individuals have extensive control over what information they can recall and what information they cannot.[3] In this work, I make the assumption that through some process, such as rehearsal, individuals can endogenously choose the likelihood of recalling a specific piece of information at a later time [4]. Naturally, individuals are endowed with an exogenous "memory constraint" that eliminates the possibility that they have perfect, unlimited recall.

In this paper, I explore an empirical regularity of information recall known as differential retrievability, or biased recall. I present a two-period model where an agent receives information in the first period that is relevant to a decision which must be made in the second period. The probability that a piece of information is recalled in the second period is endogenously determined in the first period by the agent, given a memory constraint. Given this basic environment, looking at two different information/memory structures, I derive the main result of this paper: that the differential retrievability of information is optimal, thus providing a rational choice model for biased recall.

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[1] Miller (1956) demonstrates that human memory limitations are fairly consistent across environments. The reliance on memory for information recall has not been of interest to economists until recently, e.g. where the idiosyncrasies of human memory have provided explanations for boundedly rational behavior (Mullainathan, 2002).

[2] To name but a few, information is more likely to be recalled if it was presented first or last in a series (Frensch, 1994), if the context of recall matches the context it was presented (Tulving, 1974), or if the individual was tested over the information (Roediger and Karpicke, 2006).

[3] See Storm, et al. (2006) and Anderson et al. (1994) for experimental evidence of repetition enhancing recall of certain pieces of information over others.

[4] Mine is not the first economic model to allow an agent to have some control over his own information recall (Dow, 1991). Within psychology, Rosenblatt (1958) developed a probabilistic model of information storage in the brain.

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Psychologists have long known that the ability to recall information is affected by the circumstances in which the information was encoded to memory.[5] In particular, experimental subjects are known to recall information which confirms a decision they have made at a higher rate than information which contradicts this decision (Dellarosa and Bourne, 1984). Likewise, information consistent with a subject's belief (including those born from social stereotypes) is easier to recall (Rothbart et al., 1979). In Lightle et al. (2009), subjects clearly exhibit biased recall in that they are more likely to recall information which supports their initially preferred candidate.[6] The overall findings suggest that the more certain an individual believes that condition X is true, the relatively higher is the retrievability of information which supports X compared to other information, and we say that the individual's recall is biased in favor of condition X because the expected fraction of X-supportive information recalled is higher than the fraction of X-supportive information initially available.

While biased recall may seem like a useful cognitive shortcut in decision making, it is easy to show that it may have detrimental effects. The hidden profile paradigm of group decision making is an example of a case where biased recall is suboptimal. In that paradigm, group decision making is studied in the special case where individuals have information which by itself favors one option, but if all group members effectively pooled their information and evaluated it in an unbiased way, a different option would emerge as the best choice. Groups typically fail to discover hidden profiles. (See Stasser and Titus, 1985; Stasser and Titus, 2003 for a review) While the reasons groups fail cannot be pinned to one cause, it is clear that biased recall works against finding the true optimal choice. Consistent with earlier findings, subjects considering their own information form a belief that option X is best, which makes it more likely that X-supportive information is recalled during group discussion, which makes it harder to discover that option X really is not the optimal choice.

The work most similar to this one is the very recent model of bounded memory described by Wilson (2014). With goals similar to this paper, she recasts the problem of decision making over time as a game of incomplete information where agents at time t choose a memory state in time $t+1$ after being given information about the true state of the world. Her main finding is that certain biases in the processing of information, such as salience, confirmation bias, and (most relevant to this work) belief polarization, can be rationalized as equilibrium play of a dynamic game. This paper complements her study by finding similar results while considering a different mechanism for information recall: allocating memory toward specific pieces of information, rather than choosing a state of memory.

The main question of this study is to determine whether biased recall is beneficial or detrimental, *ceteris paribus*. This question has not been answered in studies of memory allocation primarily because a rational choice based utility function has not been ascribed to modeled agents or experimental subjects. Furthermore, explorations into the cause of biased recall have focused on descriptive models of memory without considering the implications of utility maximization. By endogenizing the retrievability of information, the model I describe allows for access to this potential source of explanation. I place particular emphasis on the environment experienced by subjects in Lightle et al. (2009) where the biased recall of information seems to have the strongest effect. In Section 2, I give an example showing the optimality of biased recall in an environment similar to the group decision problem of the hidden profile paradigm. In Section 3, I show the result holds for a larger class of decision problems with imperfect recall. Section 4 concludes.

[5] Bartlett (1932) discusses a theory of schema, where memories are molded to fit within a given framework or worldview, making it difficult to recall information which does not fit the schema.

[6] These findings are seemingly reversed in the literature of incongruity resolution (Hastie and Kumar, 1979; Srull, 1981), where subjects are more likely to recall information which is incongruent with their expectations. An important contribution of the work I present here is to distinguish in which circumstances biased recall of information is optimal.

2. Biased recall in the hidden profile paradigm

In this section we consider a small group of individuals faced with the task of choosing among several possible candidates for a political office. Each individual has a proper subset of the relevant information about the candidates, while every piece of information is known by at least one individual in the group. The group is going to meet at a later time in a caucus, where information can be freely exchanged. If the pre-caucus distribution of information is such that each individual's information by itself favors a suboptimal candidate, then there is a hidden profile. However, it is important to note that no subject in a hidden profile experiment is ever told that they will be facing a hidden profile. Likewise, members of a real world decision making group cannot presume to know the exact distribution of information, or else there would be no need for the group in the first place.

To deal with this issue, I make the innocuous assumption that there is common knowledge of a uniform prior. In other words, every possible realization of the candidate's characteristics occurs with equal probability, and everyone knows this. To further simplify the problem, I consider only two group members, only two candidates, and only three characteristics for the candidates. These reductions do not fundamentally alter the environment in which subjects in a hidden profile experiment find themselves, and the intuition developed here naturally applies to broader contexts where decisions have to be made based on information that must be recalled.

2.1. The model

There are two caucus members, agents A and B, and two candidates for a political office, X and Y. There are three dimensions over which the candidates have abilities: 1. experience, 2. intelligence, and 3. personality. The abilities of the candidate have one of three objective and concrete values: “good”, “average”, or “bad”. The choice of candidate is a pure common value decision for A and B, as the caucus members' interests are aligned and utility only depends on the chosen candidate's objective abilities.

Definition 1. *The value of a candidate is the sum of $(+1)$ for each dimension over which the candidate's ability is “good”, (0) for each dimension over which the ability is “average”, and (-1) for each dimension over which the ability is “bad”.*

Both caucus members believe that “good”, “average”, and “bad” are equally likely for each candidate on each dimension. Given any uncertainty, A and B are both risk-neutral expected utility maximizers. For the purposes of this exercise, a single piece of information will be defined as the abilities of *both* candidates in a single dimension.[7]

The timing of the game is as follows:

- Time 0: Nature determines the abilites of X and Y in each of the three dimensions
- Time 1: A and B are given access to the abilities of the candidates in two randomly selected dimensions out of the three.
- Time 2: A and B each choose the probability with which they will recall each piece of information
- Time 3: Nature determines which information is recalled based on the probabilities chosen in time 2.
- Time 4: The candidate with the highest value based *only* on those dimensions recalled by either caucus member is elected (with a random candidate winning in the case of a tie) and A and B receive a utility equal to the value of the winning candidate *in all three dimensions*.

[7] This assumption is without loss of generality, because one can trivially reassign the difference between the two candidates abilities as a “relative ability” of a single candidate and consider the other candidate as being fixed or normalized to zero.

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