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Context-dependent choice as explained by foraging theory

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Abstract

An agent makes consumption choices in multiple periods. Choice objects vary in type and quality; objects of the same type are inter-temporal substitutes. The current choice set is informative about the distribution over future choice sets. Thus, the presence of unchosen alternatives may rationally alter the agent's choice. Under some simple assumptions, the optimal policy exhibits context-dependent choice behavior, such as the decoy effect and choice overload.

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1. Introduction

Bob has decided to move house to shorten his commute. Each weekend, he drives downtown and looks at apartments for sale. After viewing properties, he chooses either to buy one, or to go home and search again next week. One week, he encounters apartment A, but decides not to buy it.

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Suppose instead that, on that same weekend, Bob also visits apartment B. A and B have the same asking price, but B is clearly worse. The floors creak, the taps leak, and the rooms are cold and drafty. Seeing this, Bob changes his mind and decides to buy apartment A.

Bob exhibits context-dependent choice. When his choice set is {buy A, go home}, he goes home, but when his choice is {buy A, buy B, go home}, he buys A. The presence of an unchosen alternative changes Bob's choice. Taken naïvely, this falsifies classical choice axioms, such as the Weak Axiom of Revealed Preference (Samuelson, 1938) and the Independence of Irrelevant Alternatives (Luce, 1959).

One explanation of Bob's behavior is that he has fallen victim to the *decoy effect*, a psychological bias. The presence of a dominated alternative (buy B) increases Bob's choice rate for the dominating alternative (buy A) (Simonson and Tversky, 1992).[1] *Choice overload* is a related bias: The overabundance of choices of one type leads agents to abstain from choosing any of them (Iyengar and Lepper, 2000).

However, there is also a rational explanation for Bob's behavior. Bob is (implicitly) comparing the apartments he can buy this week with the apartments he can buy in future. He is uncertain about the quality of downtown housing, and apartment B is bad news about the apartments he might later encounter. In light of this new information, Bob decides to seize the opportunity to buy apartment A.

There is growing evidence that context-dependent choice is widespread in the animal kingdom. Animal choice experiments typically present an animal with a set of mutually exclusive food options, and record its consumption choice. The decoy effect, in particular, has been documented in animal experiments involving honey bees, gray jays, starlings, hummingbirds, and even plasmodial slime molds.[2] In order to train animals to understand the connection between physical behavior and food rewards, many of these experiments involve exposing each animal to a sequence of consumption decisions. For example, Shafir et al. (2002) offer each honeybee a sequence of 8 choices, and offer each gray jay a sequence of 48 choices. Similarly, Bateson (2002) reports that each starling "received daily sessions composed of 18 training trials followed by 18 choice trials".

When phylogenetically distant species exhibit similar behavior, this suggests that the behavior is a well-adapted response to a common problem.[3] We propose that context-dependent choice can be a well-adapted response to the problem of *foraging*; that is, the problem of making repeated consumption choices in an uncertain environment. This problem is shared by most animal species. It also contains some standard economic decisions as special cases.

In our model, an agent (a consumer shopping for goods, an animal foraging for food) makes consumption choices over multiple periods. Its key ingredients are that goods are intertemporal substitutes, and that choice sets today are informative about choice sets tomorrow. Given some simple assumptions about information, the agent's optimal single-period behavior is observationally equivalent to the decoy effect or choice overload.

[1] This is also called the *attraction effect* or the *asymmetric dominance effect*. The *compromise effect* as studied by Herne (1997), McFadden (1999), and Kamenica (2008) is also called a decoy effect by some authors, but we use the term in the narrow sense, as is common in the literature. The decoy effect is empirically robust in a variety of experiments (Huber and Puto, 1983; Ariely and Wallsten, 1995; Herne, 1997; Pettibone and Wedell, 2000; Dhar and Simonson, 2003; Bateman et al., 2008).

[2] Shafir (1994), Hurly and Oseen (1999), Bateson (2002), Shafir et al. (2002), Bateson and Kacelnik (1997), Bateson et al. (2002, 2003), Latty and Beekman (2011).

[3] Evolutionary studies of "analogous traits" (Owen, 1849) are commonplace in biology.