The road ahead for sunk costs

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Summary

The sunk cost error is usually ascribed to the “ghost” of past investments, but the “promise-of-a-better-future” account is often difficult to dismiss. The search for the underpinning mechanism(s) is ongoing, but it should go hand-in-hand with a functional account.

Keywords Sunk cost · Mechanism · Function

Rationality principles lay at the core of normative theories of decision-making in biology and microeconomics. For instance, most normative models assert that decisions between possible courses of action ought to maximize some increasing function of expected benefits and decreasing function of expected costs. Thus, only future prospects should affect current choices. Irrecoverable, previously incurred (sunk) costs should be irrelevant unless they inform the expectations of costs and benefits. Yet both human and nonhuman animals seem to mishandle frequently past costs by overvaluing options preceded by such costs—the sunk cost error. The Concorde fallacy is an application of this same notion to parental investment as discussed in evolutionary biology. These and other departures from strict rationality in both humans and nonhuman animals seem to violate the foundational principles of normative theories and are much more prevalent than previously suspected.

The sunk cost error, in particular, occurs either when (a) options preceded by some investment (money, effort, time) are preferred to other prospectively equivalent options (the work-ethic effect), or when (b) an agent persists in a particular endeavor not because of prospective gains, but because of costs already incurred. An early experiment by Arkes and Blumer (1985) illustrates this decision error. A discount was offered to buyers of season tickets to the theater. Those who received no discount attended the most plays, followed by those who received small discounts and finally by those who received the larger discount.

Similarly, pigeons prefer to complete a particular work requirement (a fixed-ratio schedule) even when they could escape such a requirement and complete a lesser one (Navarro & Fantino, 2005). In these examples as in many others, past investments in an option seem to enhance its value. Nonetheless, most demonstrations in nonhuman animals suffer from interpretative difficulties. For instance, it is not uncommon to find a confound between prospective and retrospective interpretations. Future prospects are often negatively correlated with past investments.

Recently, Sweis et al. (2018) found persuasive evidence for the sunk cost error in mice, rats, and humans using an ingenious procedure. Briefly, subjects were offered the opportunity to collect food (mice and rats) or video (humans) rewards in four locations encountered sequentially and repeatedly on a limited time budget. Each location delivered one type of food (video) reward. Upon arriving at one location, a particular delay to reward (1 to 30 s) was signaled. Subjects could either reject or accept the offer. In the former case, they would simply move to next location (where they would find a new offer); in the latter case, they would enter the location (and by doing so, start the timer) and wait, with a signal indicating the time remaining to reward. Critically, subjects could reject the offer at any point during the delay, abandon the location, and travel to the next one. The occasions on which subjects initially accepted the offer provided the opportunity for the sunk cost error to emerge. In fact, the probability of collecting a reward once an offer was initially accepted (i.e., waiting for the entire delay to elapse) was affected both by the time remaining to reward (prospective cost) and by the time already spent waiting for the reward (sunk cost) in the three species. Mice, rats, and humans escalated their commitment to a particular offer as prior time investment increased.

These new findings set the stage to examine the task ingredients that may have been critical for such a comprehensive demonstration, particularly in rodents. They also allow for a

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reexamination of the interpretative challenges remaining from both a mechanistic and a functional perspective.

Sweis et al. (2018) used a laboratory task wherein rodents could display natural foraging behaviors. Instead of choosing between two simultaneously available options, rodents had to accept or reject options presented sequentially. Contrary to most laboratory tasks, this preparation seems to capture the structure of naturally occurring foraging cycles, which most likely entail sequential encounters with prey that can be pursued or ignored (Kacelnik, Vasconcelos, Monteiro, & Aw, 2011). Previous attempts suggest that patterns of choice are quite different when “artificial” tasks are altered to emulate naturally occurring foraging scenarios (e.g., in the self-control preparation).

In fact, Sweis et al.’s (2018) procedure is a single-shot laboratory analogue of the patch exploitation problem. In the classical version, animals choose between staying in the current patch, where they experience diminishing returns, and leaving to find a new patch. According to the marginal value theorem, the optimal policy in such a scenario is to stay in the patch as long as the local rate exceeds the expected overall rate in the environment. While the version implemented by Sweis et al. does not involve local diminishing returns, it still lends itself to an optimality analysis. The analysis is complicated by a priori preferences for certain rewards (and therefore proclivities to accept longer delays for preferred items), but it is certainly worth considering what optimal foraging models would predict when travel times and environmental richness and variability are considered. Such models would not predict sunk cost errors because the decision of where to invest the next unit of time can be (and actually is) interpreted prospectively. Yet such analyses would help to unravel the role of key variables involved in this intricate task and would set the standard against which to compare animal performance.

Be that as it may, the mechanisms underpinning the sunk cost error are yet to be determined. Several proposals have been put forward over the years, but all have met successes and failures. For example, state-dependent valuation learning proposes that what is critical for determining the value of an option is not the objective benefit of the outcome (i.e., the energetic value of the ensuing reward), but how the outcome modifies the energetic state of the animal. Because the fitness (or utility) versus reserves function is concave, an option consistently encountered when the animal is in a lower energetic state (e.g., when the animal is food deprived or after physical effort) should acquire greater value than an option objectively equal but consistently found when the animal is not energetically depleted. This hypothesis presupposes that the change in state caused by the reward is in the same dimension of the initial investment (viz., energy). Within-trial contrast is a provocative alternative because it presupposes that overvaluation can occur even when the reward and initial investment are cross-dimensional. Options preceded by aversive events (not necessarily an investment; e.g., an emotionally negative event) should be preferred to those not preceded by such

events because of the greater contrast in hedonic state caused by reinforcement in the former. Tests of the state-dependent valuation learning hypothesis have been particularly successful, whereas the evidence for within-trial contrast is inconclusive. Yet the proposal that manipulations negatively affecting hedonic state prior to reinforcement also enhance value is appealing and would add generality to the effect if proven reliable.

Time is another important factor because most investments require time that cannot be recovered. When such time is factored in, an option preceded by an investment is lengthier overall than a prospectively equal option with no prior investment. Hence, even though the delay to reinforcement timed from the appearance of the options is the same, the postinvestment onset of the costlier option usually signals a greater reduction in time to reinforcement than the onset of the cheaper option. According to the delay-reduction hypothesis, this should make the signal for the costlier option a more potent discriminative stimulus such that, when offered a choice between the two options, animals ought to prefer the costlier one.

The search for the mechanism(s) underlying this error is ongoing, but a functional analysis is required, too. Preferably, mechanistic explanations and functional accounts should be considered jointly. They must inform each other such that each restricts the range of conceivable solutions to the other (Vasconcelos, Fortes, & Kacelnik, 2017). For instance, how and when is delay reduction relevant to an optimal forager? Rather than questioning normative approaches (such as the optimality modeling of behavior), violations of core rationality principles highlight the need to understand the adaptive significance of the mechanism(s) underlying such breaches.

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