Peacemaking among inconsistent rationalities?

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Kacelnik, Schuck-Paim and Pompilio (this volume, p. 377) show that rationality axioms from economics are neither necessary nor sufficient to guarantee that animal behavior is biologically adaptive. To illustrate that biological adaptiveness does not imply conformity with the consistency axioms of economics, Kacelnik et al describe animals that sensibly experiment with actions yielding sub-maximum levels of short-term energy intake to monitor their environments for change, leading to apparently intransitive patterns of choice that are nevertheless biologically adaptive. Invalidating the converse claim that economic rationality implies biological adaptiveness is Kacelnik et al's example of female ruffs that are worse off when they conform to the constant-ratio rule, frequently interpreted as a normative consistency requirement of economic rationality. Together, the two examples demonstrate that axiomatic norms are both unnecessary and insufficient for determining whether a particular behavior is biologically adaptive.

Additionally, Kacelnik et al call into question what has been reported in the animal behavior literature as preference reversals, such as risk attitudes among wild rufous hummingbirds or the food-hoarding propensities of grey jays. Kacelnik et al attribute apparent reversals to state-dependent fitness functions modulated by subtle differences in the training phase of animal experiments. For example, animals trained on menus that include a strictly dominated option will tend to have lower accumulated energy reserves and therefore exhibit systematically different patterns of choice—not because they fail to maximize, but because their training has induced systematically different nutritional states. Another possible explanation for preference reversals in animal studies with strictly dominated, or "decoy" options is that menus containing dominated items may convey valid information about future opportunities (Houston and McNamara, 1999). If menus are correlated through time, then menus with inferior options today predict scarcity in the future and imply a distinct optimal course of action, in violation of regularity assumptions that posit invariance with respect to the inclusion of strictly dominated alternatives. There are other basic examples from biology in which individual deviation from axiomatic norms is consistent with adaptiveness. For example, in environments with payoff structures that can be modeled as cooperative games, a family's best response sometimes requires individual family members to behave suboptimally as part of a diversification strategy that reduces the risk of reproductive failure (Hutchinson, 1996). Futhermore, theoretical biologists have documented the fragility of expected-fitness maximizing behaviour with respect to the assumption of stable environments. Once the model allows for shocks to the environment's stochastic structure, simple behavior rules that are suboptimal (in terms of expected fitness) when viewed narrowly from the perspective of unchanging payoffs in a fixed environment may outperform rules based on maximazation (Bookstaber and Langsam, 1985).

We congratulate Kacelnik et al for their demonstration of the inadequacy of what we call content-blind norms (Gigerenzer, 1996). Consistency axioms are content-blind, because, by definition, they are merely syntactical, without reference to semantics (what

the symbols refer to) and, as a consequence, to pragmatics (real-world goals of decision makers). Their examples illustrate the importance of clearly specifying the animal's environment and the critical role that subtle shifts in context can play in determining which norms should be applied in evaluating the rationality of observed behavior. Content-blind norms derived from domain-general axiomizations of rationality are too strict because they rule out many behaviors that are genuinely adaptive. At the same time, content-blind norms lead to overly general characterizations of rational behavior that include many behaviors that are harmful to those who adopt them.

Content-blind norms are inconsistent with ecological rationality

Kacelnik et al claim that axiomatic norms (i.e., content-blind norms), although descriptively false and normatively irrelevant in many instances, are nevertheless interesting as benchmarks of rational behavior. The authors seek to harmonize different, sometimes contradictory, definitions of rationality and report that such harmonization is already underway. We argue instead that there is a genuine conflict between content-blind and content-based notions of rationality, one that is worth highlighting and subjecting to further empirical competition rather than calling for premature peace negotiations. As Kacelnik et al's examples demonstrate, content-blind norms, by themselves, are neither necessary nor sufficient for telling reasonable from unreasonable behavior. An alternative notion of reasonableness is ecological rationality (Gigerenzer et al, 1999), which, unlike content-blind norms, is in our view consistent with long-studied notions of adaptiveness in biology. Thus, we wish that Kacelnik et al, who have taken one step, would take the next step of de-prioritizing content-blind norms and the concomitant methodological focus on deviations from consistency axioms adopted from economics and mathematical decision theory.

Following Herbert Simon, we understand ecological rationality to be the study of actual processes giving rise to observed behavior and the extent to which those processes exploit the structure of the environment in reaching task-specific goals. Consistent with Kacelnik et al's examples, ecological rationality's key criterion for assessing the reasonableness of behavior is whether a satisfactory match between behavior and the requirements of the external environment is achieved. Ecological rationality enjoys the advantage that it accommodates historically determined starting points (i.e., state-dependence) and interdependencies among individuals needed to account for social intelligence. Its flexibility in allowing for heterogeneity with respect to different environments is costly, however, in terms of its empirical demands, because its core matching concept requires context-specific descriptions of both observed behavior and the appropriate normative benchmark.

The cost-savings appeal of applying axiomatic norms to all environments and tasks is understandable in that it saves work examining precisely when and where such norms make sense as prescriptive guidelines. One wonders, however, why axiomatic norms continue to hold interest, and why measurement of deviations from axiomatic norms

remains a methodological priority, after the simultaneous narrowness and excessive flexibility of such norms have been established? We elaborate below on the simultaneous narrowness and excessive flexibility of axiomatic consistency conditions to further motivate our claim that measured deviations from axiomatic norms are a less interesting object of study than the actual processes that guide animal behavior. Describing such processes in detail and checking their performance against the requirements of the environment would seem to be a higher priority than simply noting whether observed animal behavior conforms to the consistency axioms of economic rationality.

Economists usually define rationality as a short list of domain-general axioms that require internally consistent behavior (e.g., Arrow, 1951; Debreu, 1959; Arrow and Hahn, 1971; Sen, 1993, 1997; Mas-Colell et al, 1995). In its Libertarian rhetoric of consumer sovereignty, economic theory has almost nothing to say about the rationality of any single choice considered in isolation. Instead, economic rationality applies exclusively to pairs of choices. By far, the most important restriction that economic rationality imposes on pairs of choices is the consistency axiom: *If option A is taken when B is available, then option B may be taken only when A is unavailable.*

The consistency axiom is surprisingly flexible in that, oftentimes, it eliminates very few patterns of choice as inadmissible according to its definition. Consider, for example, a decision maker who makes two choices—choice 1 from menu {a,b,c} and choice 2 from menu {c,d,e}. Because only one item belongs to both menus, there is no observable pattern of choice that can falsify the consistency axiom. Notice that choosing b from {a,b,c} reveals two pairwise rankings, b$\succ$a and b$\succ$c. And choice of c from {c,d,e} reveals the rankings c$\succ$d and c$\succ$e. To violate the consistency axiom, a reversal among revealed pairwise rankings must take place, such as a$\succ$b and then b$\succ$a. Without any pairs of objects in common across menus, economic rationality is nonbinding. Apparent violations of economic rationality observed in experimental studies are therefore extremely fragile to the alternative hypothesis of noncomparable menus from differing contexts across choice acts.

Axiomatic rationality's potential for flexibility induces economists to make further assumptions (e.g., about the contents and shape of the utility function) that often lead to extreme rigidity (Simon, 1999). The wide span of flexibility to rigidity within the economic rationality paradigm shows through particularly at the moment of analysis in which menu items are labeled—either with context-specific markers implying that all choices are rational or without context markers, in which case absolute uniformity across choice contexts is necessarily assumed. A taste for variety (e.g., choosing *apple* from the menu {apple, orange} on Monday, and *orange* from {apple, orange} on Tuesday) can be made to satisfy the consistency axiom by partitioning the space of consumption bundles to include dates. Given that *A on Monday* was chosen over *B on Monday*, the consistency axiom does not imply that *A on Tuesday* is preferred over *B on Tuesday*. *A on Monday* and *A on Tuesday* are considered wholly different objects of choice, as distinct as guns and butter. Note, too, that apples on Monday are distinct from apples on Tuesday, not because preferences have changed, but because the contexts of choice are

possibly different. If, on the other hand, day-of-the-week labels are dropped from the description of apples, then those who sensibly pursue variety in fruit consumption over the course of the week are rigidly categorized in the irrational category.

Although the potential flexibility of economic rationality is sometimes presented as one of its chief selling points, flexibility is viewed by many of its critics as economic rationality's foremost flaw. Economic rationality is, by design, unhinged from moral, ethical, and other widely accepted normative criteria, including biological fitness, criteria that take much stronger stands in ruling out specific one-off behaviors (not just inconsistent pairs) as irrational. Suicide, addiction, ethnic hatred, war, corruption, terrorism—virtually any anti-social behavior one can imagine, as well as pro-social behavior of many varieties (see, for example, Fehr and Schmidt [1999])—are routinely rationalized according to the elastic notion of economic rationality.

The convergence story

Observing that consistency-based economic rationality has become prominent in the animal behavior literature, Kacelnik et al set out to compare and contrast economic rationality *vis a vis* biological rationality, while distinguishing them from two other forms of rationality, namely, philosophical and psychological. A key theme of Kacelnik et al is that economic rationality is often violated by human subjects in psychological and experimental economics. They argue that the many studies from recent decades in psychology and economics that challenge the descriptive validity of axiomatic rationality are leading toward a harmonization of rationality perspectives, converging to Kacelnik et al's preferred multi-rationality concept of rationality. They see a convergence of perspectives among participants in the rationality debates (p. 385):

> The convergence between human cognitive psychologists, economists and biologists in both considering and questioning the paramount role of consistency is promising: while all of them find that the axioms of microeconomic theory that defined [economic] E-rationality are systematically violated by decision-makers under many experimental circumstances, there is a growing realization that this does not imply that decision-makers operate inefficiently in real life.

It would be nice if that were the case, but unfortunately it is not. Economists who are most sympathetic to psychological research generally believe that errors are ubiquitous and damaging (Thaler, 1991; Conlisk, 1996; Camerer et al, 2003), implying that governments should intervene paternalistically to "de-bias" individuals beset by a pathological mélange of psychological biases (O'Donoghue and Rabin, 2003; Thaler and Sunstein, 2003; Choi et al, 2005). The sentiment is traveling fast into legal scholarship and academic disciplines that analyze politics, policy, constitutions and the design of other important institutions (Jolls et al, 1998; Trout, 2005).

Observing that consistency axioms fail to describe what people do—people, by the way, who get into college, hold jobs, sustain long-term social interactions, and interact with myriad cultural institutions without violence or other noticeably disruptive frictions—the key question of interpretation is whether it is the axioms or the people who are at fault. Behavioral economics explicitly sides with the axioms and their normative requirements, leaving no choice but to label actual human behavior, however normal and functional, as pathological and mistaken (see, for example, Thaler's [1991] *Quasi Rational Economics*, Camerer et al's [2003] *Advances in Behavioral Economics*, and Kahneman's 2003 Nobel lecture, "Maps of bounded rationality: Psychology for behavioral economics").

Herein lies a critical debate. Given that standard axiomatic norms of rationality are empirically false, does one hang on to the axioms and fault people's behavior, or drop the axioms as irrelevant? We will discuss cases (as Kacelnik et al do, although with different interpretations) in which axioms are violated and people nevertheless perform well, calling into question the normative relevance of such axioms.

Contrary to what one might infer from Kacelnik et al's optimistic account, the debate over how to interpret empirical departures from axiomatic norms is not very well covered in economics or psychology. The distinctions between dominant biases-and-errors interpretations (Kahneman et al, 1982) and alternatives put forward by those working in the smart heuristics paradigm (Gigerenzer et al, 1999) need to be emphasized, not papered over.

By developing a methodology focused on deviations from axiomatic rationality, one in fact strengthens the normative centrality of the axiomatic approach. Many, even those who are open to the idea of smart deviations from axiomatic rationality, such as Kacelnik et al, apparently fail to see this. For example, Kacelnik et al write: "The gold standard of consistency embodied in E-rationality axioms, even if violated by real subjects, provide[s] yardsticks against which to assess behavior," (p. 385).

But why? Once we realize that sensible, reasonable, and functionally effective behavior need not adhere to rationality axioms, it follows that the rationality-axiom yardstick is of limited relevance. The real question is the extent to which behavior is functional, well-performing, and well-matched to currently existing institutions. We will see that the consistency axiom has no predictive power concerning the performance of behavior evaluated by these criteria.

Rejecting consistency and keeping it?

Kacelnik et al define biological rationality as "consistent fitness maximization." As the authors point out, this is merely economic rationality with an additional constraint, namely, that the function being consistently maximized is specified in an objective sense determined by externally given biological structure. As a logical consequence, biologically rational behavior is a subset of economically rational behavior, and *biologi-*

cally rational implies *economically rational.* The converse is not true, of course, because the weaker concept of economic rationality merely requires consistency while placing virtually no restrictions on the objective (perhaps a weighted combination of goals) being pursued. As emphasized earlier, the "best" in economics has no essential content—only the restriction that what is not best now may not later become best as long as the current best is still available. It is also the case that, by framing choice as an optimization process, the economic model obviates the need to deal with the important real-world problems of searching for alternatives, getting to know what is possible, and learning how actions relate to anticipated payoffs.

It is unclear whether Kacelnik et al approve of the normative authority of the consistency requirements they write about, such as transitivity. For example, they observe: "If preferences are non-transitive it is fair to assume that the decision makers are not consistent in choosing the best for them, namely, are not rational" (p. 381). Are they reporting the way economists think, or are they agreeing with the standard normative claim?

We now demonstrate that decision processes may be intransitive and nevertheless systematic and sensible. In so doing, we intend to call into question why transitivity should be held out as a litmus test for rationality. See Brandstätter, Gigerenzer and Hertwig (2006) for another example of a sensible albeit intransitive decision procedure that, additionally, is shown to predict the choice behavior of nonpathological human subjects better than models that assume transitivity do.

The following example is adapted from Rubinstein (1998). Consider a decision task in which one picks an item from a long catalog, (c, a, z, …, b), with items arranged sequentially according to the catalog-maker's pagination scheme. If forced to choose among pairs of items, we suppose that the decision maker prefers item a over item b, b over c, and—respecting transitivity—a over c. However, because the catalog contains many pages and time is scarce, the decision maker adopts the following shortcut decision rule: *Consider the first and last item in the catalog and take the best among the two.* This decision rule is quick, perfectly systematic, and for some weighting of time costs and expected marginal benefits from searching through the middle pages of the catalog, yields payoffs that are just as good as those of maximization (although this is not the essential point). The main point is that the decision rule generates preference reversals, is therefore intransitive, and yet its performance is not necessarily bad.

According to the economic theory of rational choice, the sequence in which feasible sets are expressed should play no role, since optimization is defined by picking the maximal item from a set, and sets, as mathematical objects, have no intrinsic order. (Unlike vectors, which can be used to represent ordered objects such as catalogs, menus and search paths, sets are order-free. For example, the sets {1, 2, 3} and {2, 1, 3} are equivalent, and the most preferred item from each set must, by definition, be the same.) However, logically equivalent expressions of the feasible set—that is, catalogs with the items arranged in different sequences—result in inconsistent choices. Our claim is that this kind of inconsistency cannot a priori be assigned a negative interpretation.

When presented with the catalog (c, a, z, …, b), the shortcut decision rule considers c and b, and chooses b, even though a is available. Choosing b when a is available implies, according to standard economic theory, the revealed ranking of b over a. When presented with the same choice set arranged in a different sequence, in the form of the alternative catalog (a, b, z, …, c), the shortcut decision rule considers a and c, and chooses a. Because a is chosen when b was available, the revealed ranking is a over b. The inconsistency of the shortcut rule in generating implied rankings of a over b, and b over a, depending on the ordering of the catalog's contents, is precisely the kind of inconsistency ruled out by axiomatic economic rationality. Nevertheless, the decision rule is sensible and systematic. Is the axiom or the behavior at fault?

The dominant interpretation of preference reversals and other deviations from axiomatic consistency requirements in economics, psychology and, increasingly, throughout the social sciences, is that the axioms are correct and people using such shortcut rules must be wrong. We must protest against this interpretation and ask its proponents for clearer explanations. If reasonable behavior is possible with or without axioms, what is the appeal of studying domain-general consistency requirements?

Sen (1993) provided at least one negative answer to that question, suggesting that domain-general consistency requirements, at least in social choice problems, may have no intrinsic appeal—that external values relating actions to context-specific meanings are required in all cases to make sense of behavior, and to make normative judgments distinguishing reasonable from unreasonable behavior. A priori consistency requirements without specification of the context in which choice occurs are themselves unreasonable according to Sen. It is surprising that Kacelnik et al cite Sen without absorbing his central point regarding the arbitrary and therefore unhelpful role of internal consistency requirements, as opposed to the context-derived "entailed consistency," which Sen defends.

Inconsistent content-blind norms

In addition to economic and biological rationality, Kacelnik et al briefly consider philosophical and psychological definitions of rationality, emphasizing the message that rationality has many flavors, all with distinct virtues and nuances. They are right: Psychological rationality is not of one piece; it is a patchwork. Although psychology has many content-bound moral, developmental, and social norms, in recent times, many psychologists have adopted similar content-blind norms to those of economic rationality.

Consistency and other laws of first-order logic are content-blind because, by definition, semantics and pragmatics are ignored in logic. The existence of multiple norms and the fact that one has to justify a norm by studying what goals a person is trying to achieve are suppressed by those who compare people's judgments simply "with an accepted rule of arithmetic, logic, or statistics" (Kahneman and Tversky, 1982, p. 493). In this spirit, psychologists have evaluated the behavior of others against the laws of the

truth table, Bayes's rule, expected utility, consistency, and other statistical principles. The problem is that these norms are not the same. For instance, beginning in the 1960s, psychologists declared people's choices in one of the most widely researched reasoning problems, the "selection task," as irrational because the choices deviated from the laws of logic. Yet when others applied Bayes's rule to the same problem, people's choices were rehabilitated as rational (Oaksford and Chater, 1994).

Similarly, since the 1970s, psychologists have interpreted a certain pattern of judgments as exhibiting overconfidence bias, and another as evidence of the regression fallacy (i.e., misinterpreting statistical regression as a substantive effect). Yet the pattern called overconfidence turned out to be a direct consequence of regression towards the mean (Erev et al, 1994). The norm of the day turns into the fallacy of tomorrow (for more, see Gigerenzer, 2004). Our general point is that psychology is a good case from which one can learn the lesson that content-blind norms tend to be inconsistent with one another and lack the potential to produce insight into the adaptive nature of behavior.

Why not move on?

Kacelnik et al may sincerely hope to harmonize the overlapping interests of animal behavior researchers and economic and psychological researchers focused on biases and errors with the ecological rationality paradigm of Gigerenzer (2000), Gigerenzer and Selten (2001), and Smith (2003). The two approaches are in unmistakable disagreement with each other, however, and Kacelnik et al's peacemaking appears premature.

Perhaps the strongest case for harmonization that Kacelnik et al make concerns state-dependent preferences. State-dependence in economics is illustrated, for example, by the observation that consumers' willingness to pay for umbrellas goes up when it rains; that the value of savings usually declines when one has a terminal illness; and that the consumption of classical music can increase the marginal benefit of subsequent listenings to classical music (Becker, 1996). This is a rather old subject within economic theory, however, and the idea that the added complexity state-dependent preferences can rationalize apparently inconsistent pairs of choice is not at all consistent with the main criticisms of the biases-and-heuristics program based on ecological rationality.

Another rationalization of observed suboptimal choices comes from theories of learning and experimentation. Choosing in an apparently inconsistent manner sometimes provides information about the range of choices available to the decision maker, and about the state of the environment and whether it has recently changed. If the benefit of information is high and the cost of slightly suboptimal behavior is low, the standard economic framework permits one to rationalize a certain amount of randomization and experimentation, implying the rationality of suboptimal action in the neighborhood of optimal actions. This again is appreciably removed from ecological rationality's key criticisms of biases-and-heuristics research and its determined measurement of deviations from axiomatic rationality.

Kacelnik et al's sympathy for axiomatic rationality and as-if models of animal behavior is inherently in conflict with ecological rationality. Such sympathies are revealed by references to "biological optimality" without acknowledging that concept's inherent weakness as discussed by Simon (1978): noncommensurable multiple objectives, tension between individual and group adaptiveness, and fundamental uncertainty in the environment (i.e., the kind that cannot be folded into the machinery of mathematical probability theory because event spaces are not specified and probabilities are unknowable). Thus, the authors appear to reject the main idea behind ecological rationality—behavior evaluated by success in its own environment rather than by content-blind norms—although they politely repeat its conclusion that departures from axioms need not imply pathological behavior.

Kacelnik et al get closest to ecological rationality when they provide examples from the animal behavior literature in which consistent behavior is maladaptive, and inconsistent behavior is adaptive. In light of the author's empirical observations the most obvious question would seem to be why consistency requirements hold any further interest at all. (See Kirman's [1993] study of ant behavior for an economic analysis of aggregate efficiency without individual rationality.)

Kacelnik et al claim to have exposed "contradictory meanings assigned to rationality" (p. 392). Encouragingly, they write, "each flavour of the concept, however, is useful in different ways" (p. 392). They are optimistic that "animal behavior research can benefit by referring to [the economic] framework" (p. 329). But they do not say how. The evidence they present showing that consistency does not guarantee adaptiveness seems to suggest the opposite conclusion.

Should one be persuaded, as Kacelnik et al assert, that "documented violations of rationality in humans inspire new animal research" (p. 393)? And that "[r]ationality and its tribulations may foster truly multidisciplinary progress in understanding animal choice" (p. 393)? Such sentiments are likely to make friends, but whether they can lead to scientific progress is doubtful.

Successful organisms are well adapted to their environments. This is the simple essence of ecological rationality. In contrast, axiomatic norms of self-consistency divert the research agenda to the study of individual deviations from these norms, which necessitates a proliferation of flavors of rationality: philosophical, psychological, biological, economic, etc. Kacelnik et al think that we should celebrate multiple flavors of rationality, be open to possible synergies and overlaps, and—above all—not talk rudely about instances in which they disagree. Rather than joining this peacemaking program, we prefer to emphasize differences and distinctions that, we believe, will guide empirical decision-making science toward a clearer understanding of how real organisms behave.

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