JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1995, 64, 397–404 NUMBER 3 (NOVEMBER)

BEHAVIORAL ECONOMICS WITHOUT ANOMALIES

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Behavioral economics is often conceived as the study of anomalies superimposed on a rational system. As research has progressed, anomalies have multiplied until little is left of rationality. Another conception of behavioral economics is based on the axiom that value is always maximized. It incorporates so-called anomalies either as conflicts between temporal patterns of behavior and the individual acts comprising those patterns or as outcomes of nonexponential time discounting. This second conception of behavioral economics is both empirically based and internally consistent.

Key words: acts, behavioral economics, concurrent schedules, economics, maximization, operants, patterns, rationality, self-control

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At a recent forum on behavioral economics for investment advisors, the opening speaker, a billionaire mutual fund manager, listed 24 common errors people fall into when making decisions.[1] The speaker implied that there were two ways in which the audience could use the list: first, as a checklist to make sure none of the errors appear in our own behavior, and second, to exploit the errors of others for our own financial gain. (The first item on the list, readers of this journal may be happy to note, was failure to appreciate the effects of reinforcement.)

The speaker reflected the common view of behavioral economists in both economics (Loewenstein & Prelec, 1992; Scitofsky, 1976; Thaler, 1991) and cognitive psychology (Kahneman, Slovic, & Tversky, 1982) that behavioral economics is the study of error—of deviation from rational behavior. Rational behavior in turn is defined as behavior that maximizes value. These economists and psychologists recognize that subjective value (utility) may vary nonlinearly with the amount of a good (a reinforcer) via the law of diminishing marginal utility; behavior that conforms to the law of diminishing marginal utility is therefore not irrational and is part of microeconomics per se rather than behavioral economics.

One group of economists (e.g., Stigler & Becker, 1977) incorporates "psychological" goods, such as social approval, emotional satisfaction, and avoidance of fear and guilt, into subjective value. Like behavioral maximization theorists (e.g., Allison, 1983; Green & Rachlin, 1975; Hursh, 1980; Rachlin, 1980), they would incorporate all behavior into economic theory. However, their behavioral theories, unlike those of behavioral maximization theorists, connect to data only on a macroeconomic level (inputs and outputs of firms and states). Hence, the individual utility functions they derive have only indirect support.

Another group of economists, opposed to behavioral economics, are believers in the model of "rational expectations" (Begg, 1982). These economists say that although individuals may be prone to errors in their decisions, the mechanism of the marketplace will iron those errors out; although individuals may be irrational, markets are rational.

The problem common to of all of these economic views is that they are based on a rational axiomatic system (Newman, 1965). The science of economics can explain behavior only by means of rationality, either by incorporating all behavior into itself (Becker, 1976) or by setting some behavior off to the side and labeling it as "anomalous" (Thaler, 1991).

Acts and patterns. The present approach schematized in Figure 1 takes a relative rather than an absolute view of rational behavior. An *act* (X or Y) is defined as a relatively brief behavior, and a *pattern* (A or B) is a relatively extended, repeated behavior. The distinction between acts and patterns is intended to be a relative one. Thus, an operant, such as a rat's lever press or a pigeon's key peck, may

This article was prepared with the help of a grant from the National Institutes of Health.

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[1] "Behavioral Economics For Financial Decision Makers," sponsored by The Cambridge Center for Behavioral Studies, Cambridge, October 5–6, 1994.

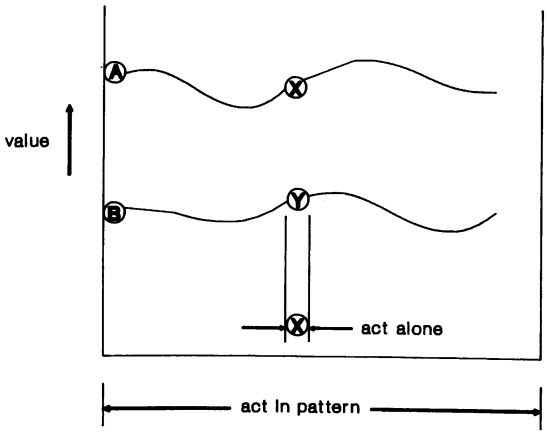

Fig. 1. Representation of a higher valued pattern (A) containing a lower valued act (X) and a lower valued pattern (B) containing a higher valued act (Y). Pattern A is chosen over Pattern B, but Pattern B is exhibited in behavior through repeated choices of Act Y over Act X.

be a pattern with respect to the sequence of movements comprising it but an act with respect to the entire reinforcement schedule. The difference between the concept of an operant and the concept of a pattern (as it is used here) is that an operant is defined by its *extrinsic* consequences (Skinner, 1938), whereas a pattern is defined by its *intrinsic* value. Consider, for example, the typical fixed-ratio break-and-run pattern. The operant here is the individual lever press or key peck because lever presses and key pecks increment the ratio counter and directly cause the extrinsic reinforcer delivery. The complete pattern, however, is the pause plus the rapid responding *plus* consumption of the reinforcer. The complete pattern may have one position on the value scale of Figure 1, but any of the acts comprising that pattern (the break, the run, or the food consumption) may have another position (higher or lower). Any of the acts, however, may be considered a pattern relative to (and may have a position on the value scale different from) its components. It is clearly not the case, moreover, that the value of a pattern is merely the sum of the values of its component acts. Patterns may have much higher or much lower values than their components. As Staddon and Simmelhag (1971) have shown, the order of acts in a pattern matters. Interim behavior followed by terminal behavior followed by food consumption is much higher in value than terminal behavior followed by interim behavior followed by food consumption.

Rationality and self-control. The question to ask about the rationality of any given choice among acts is not "Is choice of Act X rational?" but rather "Does Act X fit into Pattern A?" For a narrower act to be rational with respect to a wider pattern means that the act fits into the pattern (much as the if clause fits into the then clause in an if-then statement). In the schema of Figure 1, rationality refers only to relations between acts and patterns of acts, not to individual acts themselves.

From this viewpoint (Rachlin, 1995), so-called rational behavior is identical to self-control, and so-called irrationality is identical to impulsiveness. For example, Rachlin and Green (1972) found that food-deprived pigeons preferred a pattern of a 14-s pause followed by 4 s of eating, rather than a 10-s pause followed by 2 s of eating followed by a 6-s pause. Yet, after a 10-s pause, if allowed to choose, they preferred 2 s of eating followed by a 6-s pause to a 4-s pause followed by 4 s of eating. The latter choice is irrational only in the sense that it is inconsistent with a previously chosen pattern. Similarly, in the case of human self-control, the act of accepting and drinking an alcoholic drink as such is neither rational nor irrational. However, the act may fit in or fail to fit in with a wider pattern. Taking a drink does not fit with a prior choice to be a teetotaler (say by joining Alcoholics Anonymous), yet it does fit into a pattern of moderate drinking. An act may fit into a pattern but the pattern may not fit into a still-wider pattern—the act of tying a good noose fits into the pattern of hanging yourself, even though suicide may not fit into the pattern of living a good life.

Cognitive theories (Kahneman et al., 1982) are designed to explain irrational behavior. The explanations rest on a rational or quasi-rational base, distorted by perceptual or cognitive biases (i.e., anomalies). But for every logical anomaly (the stuff of behavioral economics according to cognitive psychologists and economists), there exists a functional context (a "frame," in cognitive terms) in which the anomaly disappears. A proper goal of behavioral economics as an explicitly behavioral enterprise is the discovery of that context. In other words, behavioral econom-

ics should not end with the discovery and categorization of anomalies but must go further to find their functional base in the environment.

Maximization and self-control. Self-control and impulsiveness are generally understood in terms of a conflict between "interests" (Ainslie, 1992). Impulsiveness is said to be dominance of lower interests ("passions"), whereas self-control is dominance of higher interests ("reason"). Thus, impulsiveness is commonly identified with irrationality (i.e., failure to maximize). Rachlin (1995) presents a relativistic model of self-control and impulsiveness (see Figure 1) in which the underlying conflict is not between reason and passion as two internal forces but between temporally wider patterns of behavior and temporally narrower acts. In Figure 1, Pattern A containing Act X is more valuable than Pattern B containing Act Y. As components of the wider patterns, X is preferred to Y. As individual acts in a narrow context, however, Y is preferred to X. For example, Siegel and Rachlin (1995) found that pigeons preferred Pattern A (30 pecks followed by a pause followed by approximately 4 s of eating) to Pattern B (30 pecks followed by approximately 2-s of eating followed by a 6-s pause). Yet, as in the Rachlin and Green (1972) experiment, subjects strongly preferred Component Y of Pattern B (2 s of eating followed by a 6-s pause) to Component X of Pattern A (4-s pause followed by 4 s of eating).

In human self-control, for example, a healthy diet (A) is generally preferred to an unhealthy diet (B), but a component of a healthy diet such as eating a fruit cup for dessert (X) may be strongly dispreferred to a component of an unhealthy diet such as eating an ice cream sundae for dessert (Y). Choice of A over B maximizes value over a relatively wider period, and choice of Y over X maximizes value over a relatively brief period. Choice of X over Y is rational only in the sense that it obviously fits into a highly valued temporally wider pattern (A). But it is also possible to rationalize choice of Y over X. To take perhaps far-fetched examples, being overweight may serve the function of keeping a boy dependent on his parents or keeping a married woman away from sexual temptation. As Ainslie (1992) points out, a wider interest (social dependency) may act in concert with a relatively immediate interest (the taste of the food) to dominate a mid-range interest (a healthy diet). The crucial question for self-control is whether a preferred act does or does not fit into a preferred pattern. The behavior therapist in individual cases, like the behavioral economist in the general case, may search for valuable patterns into which a given act fits.

Maximization, from this point of view, is strictly relative and conditional. Maximization (like matching; see Rachlin, 1971) is not an empirical fact to be confirmed or denied but a technique of behavioral analysis. The question to ask is not whether animals maximize overall food reinforcement. Clearly they do not. The question to ask is, "What do animals maximize?" We cannot presume to know what an organism (including ourselves) values. Rather, value must be defined by choices. The pigeon that chooses the smaller but more immediate over the larger but more delayed reinforcer is maximizing hyperbolically discounted value as is the pigeon that matches on concurrent variable-interval (VI) variable-ratio (VR) schedules.

Maximization and impulsiveness. A fundamental assumption common to economics and behavioral economics is that behavior maximizes value. The assumption is a formalization of the behavior analyst's maxim, "The client is always right." But this assumption cannot apply in a simple form over an infinite time. No one prefers $10 in 10 years to $9.99 right now. As previously indicated, Rachlin and Green (1972) found that food-deprived pigeons strongly preferred an immediate 2-s food reinforcer (followed by a 6-s pause) to double that amount delayed by 4 s; many studies before and since have found that delay diminishes value—that animals are more or less impulsive. Impulsiveness cannot be treated as an anomaly in behavioral economics. Moreover, no particular discount function can be held to be more rational than others. Economists tend to view exponential discounting as rational and all other discount functions as irrational. But as Mazur (1987) has shown and others have confirmed, hyperbolic discounting describes choice among delayed rewards more closely than does exponential discounting. To be meaningful, behavioral economics must be able to incorporate any form of temporal dis-

counting; impulsiveness must be consistent with maximization of value.

The object of this article is not to search out all of the so-called "evidence" against maximization theory and show that each instance reduces to yet another demonstration of delay discounting; rather, the object is to present a form of behavioral economics that incorporates impulsiveness in such a manner that impulsive behavior will not even seem to contradict the theory. Nevertheless, it may be worthwhile to argue briefly against one apparent contradiction of maximization theory—the finding with concurrent VI and VR schedules that pigeons match relative rate of responding to relative rate of reinforcement but do not maximize overall rate of reinforcement. This finding has been held (e.g., Heyman & Herrnstein, 1986) to constitute decisive evidence against maximization. The argument may be summarized as follows: The concurrent interval-ratio situation somewhat resembles a choice between a sinecure (the interval component), for which one only has to show up to get paid, and a piecework job (the ratio component). A person who held both jobs simultaneously and desired only to maximize total income would work nearly all the time at the piecework job and just show up at the sinecure every once in a while to collect the waiting check. In the concurrent VI VR case this tendency should be reflected by a strong bias towards the VR component (overall reinforcement rate would then be maximized), yet little or no bias toward the VR is observed. Therefore, maximization theory is false.

This empirical finding of lack of strong bias toward the VR is consistent with maximization theory only if there were a strong preference for immediate over even slightly delayed rewards (like that found by Rachlin & Green, 1972) counterpoised to global maximization. There is indeed such an effect. It is essential to the nature of VI schedules that the interval timer keep running until a VI reinforcer is programmed, even while the subject is responding on the alternative (ratio) component. (In the sinecure-piecework choice, the sinecure clock would keep running and payment would be held for pickup even if the worker hardly ever stayed at the sinecure.) During the VR component, when a VI reinforcer is programmed, the VI timer is stopped and that reinforcer is postponed until a changeover to the VI component occurs. This has two consequences: First, postponing the reinforcer creates a spike of very high reinforcement rate immediately after changeover to the VI component; second, the stopping of the VI timer lowers the overall VI reinforcement rate. Although at matching the local VI and VR reinforcement rates are equal, the moment-to-moment local reinforcement rate during the VR component is flat (or accelerated, if the subject pauses before starting to respond after a changeover to the VR), whereas the moment-to-moment local reinforcement rate during the VI component is in the shape of a spike (a period of very high-probability reinforcement followed by a flat lower rate). The longer the subject spends in the VR component, the higher the spike. Thus, changeovers to the VI are often immediately reinforced, whereas changeovers to the VR are not. This creates a strong impulsiveness bias toward the VI component to counteract the maximization bias toward the VR. (In the sinecure-piecework choice, changeovers from the piecework job to the sinecure would often be immediately reinforced by the waiting check, whereas changeovers back to the piecework job would be reinforced only after the required work was completed.) It might be thought that the changeover delay (COD) commonly used with concurrent VI VR schedules would lessen this impulsiveness bias. But, although reinforcers cannot be delivered during the COD (equivalent in the sinecure-piecework case to a long distance between job locations), the VI typically does run, which further increases the probability of reinforcement immediately afterward. Without a COD, subjects may switch back and forth between components so rapidly that the spike has no chance to build up, and it is exactly then that matching breaks down (Heyman & Herrnstein, 1986).[2]

[2] It may be objected that melioration theory (Herrnstein & Vaughan, 1980) provides a simpler explanation for matching on concurrent VI VR schedules than does the canceling out of maximization and impulsiveness. But melioration theory, like maximization theory, must incorporate impulsiveness. Once it is pointed out that the moment-to-moment local VI reinforcement rate is not flat, melioration must predict a strong bias for the VI; a result that is not found. Another conceivable objection

Maximization theory stands or falls not on the basis of the results of this or that experiment but rather on the basis of its usefulness in analyzing behavior. The alternative technique—an absolutely normative theory of rationality together with a set of anomalies—has become awkward and cumbersome as anomalies have begun to pile up.[3]

The structure of patterns. A mechanism underlying the effect of patterning was suggested by Ainslie (1992). According to Ainslie, a given choice is influenced not only by its immediate alternative outcomes (X and Y) but also by past choices. A positive feedback loop explains the coherence of patterns. For example, at a department wine-and-cheese party a teacher who has a lecture to give that evening may apparently face two alternatives: Drink a glass of wine and enjoy the party slightly more (Y) or have a soft drink and give a slightly better lecture (X). Given these two alternatives alone, the teacher might well have chosen to have the drink. This, despite the fact that, in a string of wine-and-cheese parties and a string of lectures, the teacher prefers to give slightly better lectures (A) than to have slightly more fun at the parties (B). But the teacher's present choice is influenced by his own past choices, not just by X and Y. If he has refrained from drinking at wine-and-cheese parties in the past and if the positive feedback is strong, he is more likely to refrain from drinking at this party and thus more likely to attain the higher valued pattern (A) consisting of a string of slightly better lectures as opposed to (B) a string of slightly better wine-and-cheese parties.[4]

This feedback mechanism suffices to explain the "soft commitment" of pigeons in which the initial responses of a series prevent a reversal of choice from following a reversal of preference between X and Y (Siegel & Rachlin, 1995). The model is essentially a nonconnectionist version of Thorndike's (1911) law of exercise as independent of and in competition with his law of effect. One problem with the model is that without extensive elaboration it cannot explain how more elaborate patterns are constructed and maintained. Suppose at wine-and-cheese parties, in addition to Pattern A (abstinence) and Pattern B (alcoholism), another "higher" alternative was Pattern A*, moderate drinking. Moderate drinking might achieve a still wider maximization than either abstinence or alcoholism because it enhances collegiality, mental health, and perhaps even physical health. A pattern of moderation is generally more valuable than either overindulgence or abstinence, but in many cases (the use of cocaine, for instance) a moderate pattern of use may be difficult to achieve.

Certainly some molecular mechanism must underlie the development of behavioral patterns. A more traditional alternative model (Mowrer, 1960) holds patterned responses together with the glue of a series of internal conditioned stimuli that work backwards to reinforce and punish earlier acts. Ainslie's (1992) feedback theory and Mowrer's two-factor theory, like Herrnstein and Vaughan's (1980) melioration theory, accord with maximization for the most part but may deviate

to the maximization-impulsiveness account of concurrent VI VR behavior centers on the question, "Why should maximization and impulsiveness exactly balance each other to precisely produce matching?" There are two responses to this question. First, its presumption is incorrect. Concurrent VI VR data are highly variable; individual subjects deviate from matching in both bias and sensitivity. Second, over a fairly wide range of response distributions, matching is forced by the VI VR contingencies (Silberberg, Thomas, & Berendzen, 1991). The degree to which precise matching is forced is under dispute, but the matching obtained with these schedules is quite imprecise.

[3] The pattern of behavior of an individual from time to time is analogous to a pattern across individuals in social space but at a given time. The conflict between maximization over a brief temporal interval and maximization over an extended temporal interval (illustrated in Figure 1) is analogous to the social conflict epitomized by the tragedy of the commons or by prisoner's dilemma games (Collard, 1978). Applying Figure 1 to social conflict, X and Y represent individual interests and A and B represent group interests. For the individual farmer or the individual fisherman, it is more profitable to graze as many cattle or send out as many boats as can be afforded (Choice Y). But, because grazing land and fish are limited resources capable of exhaustion, it is better for the group of farmers or fishermen to restrict grazing and fishing to levels that allow the resource to renew itself (Choice A).

[4] Ainslie goes on to speculate that the influence of the feedback mechanism is responsible for our feeling of self-control or exerting our own willpower when we choose larger delayed reinforcers over smaller immediate reinforcers. But this contradicts the feeling of helplessness in the face of compulsions (as in the case of the compulsive miser or compulsive hand washer) when the feedback mechanism grows so strong that it overwhelms long-term maximization as well as short-term maximization.

from maximization at crucial points. Because such models posit forces that may oppose maximization, they imply "irrationality." Ainslie's feedback mechanism, for instance, is an anomaly: an exception to the general economic rule that defines value (or utility) in terms of choice. Even if some such mechanism were found to be consistent with physiological facts, it would still behoove the behavioral economist to ask, In what way is it consistent with maximization? Or, in other words, what function does the mechanism serve? If the mechanism seems to establish highly complex patterns in behavior, then the behavioral economist needs to ask, How does the formation of highly complex patterns maximize value?

One-factor theory. Mowrer's (1960) theory of reinforcement is explicitly a two-factor theory (classical and instrumental conditioning combine to generate response chains). Ainslie's (1992) theory, less explicitly, also posits two factors: the law of exercise and the law of effect. (Rachlin, 1995, also erroneously implies that the law of exercise is consistent with a maximization model.) Even ostensibly one-factor theories such as Thorndike's (1911) connectionist law of effect, Skinner's (1938) concept of reinforcement, and Herrnstein's (1970) relative law of effect all posit two kinds of variables: instrumental responses on the one hand and reinforcers on the other. What then would a true one-factor theory be like?

Timberlake and Allison (1974), in an economic deconstruction of the law of effect, interpret Premack's (1965) earlier theory as involving only one factor: the relative value of responses. The self-control theory presented above and illustrated in Figure 1 is another interpretation of Premack's theory as applied to patterns of responses. The difference between Skinner's conception of reinforcement and the present version of Premack's theory corresponds to a difference between two modern interpretations of Aristotle's concept of *final cause* (Ackrill, 1980). According to one interpretation, a final cause is like a Skinnerian reinforcer: The final cause causes the instrumental act upon which it is contingent. According to another interpretation, a final cause is a pattern of acts: The final cause causes the acts comprising the pattern. Rachlin (1994) argued that the latter conception embraces the former. According to the latter conception, when eating a food pellet reinforces a lever press, the act of pressing the lever and the act of eating the pellet together form a unit (an economic package) that has its own intrinsic value, a value that may be higher, lower, or between that of eating the food pellet or pressing the lever separately. Premack (1971) defended his reinforcement theory by claiming that electrical brain stimulation (EBS) alone is not a normal reinforcer but is only the end of a pattern, the initial part of which is the response upon which EBS is contingent. Extending this concept to eating and lever pressing, a rat's food-reinforced lever pressing may be conceived as a set of economic packages, each consisting of a lever-pressing rate and an eating rate. If the rat fails to choose the package containing the highest reinforcement rate, it may be because of the value of leisure (Green, Kagel, & Battalio, 1982), the cost of lever pressing (Green, Rachlin, & Hanson, 1983), the nature of the delay discount function, or the value of some other not-yet-understood commodity. To be consistent, maximization theory cannot separate choice from value. The rat may fail to choose the package with the highest reinforcement rate, but it must choose the package of the highest overall value. Otherwise anomalies will begin to accumulate.

Elevation of value by elaboration of pattern is itself a pattern that cuts across many areas. For instance, despite the similarity in name, the workaholic is less like the alcoholic than he is like the teetotaler. The workaholic's so-called addiction to work is really the compulsive avoidance of a narrow choice between work and leisure, a choice that by definition will always be resolved (if it is framed narrowly enough) in favor of leisure. For most people, however, all work is better than all leisure (sloth), just as complete sobriety is better than complete drunkenness. But the more abstract patterns—a balance between work and leisure or a balance between alcoholic drinking and sobriety—are more valuable still. For example, the drunkard's behavior may be explained narrowly in terms of a series of individual choices of a higher valued drink over a lower valued alternative; the teetotaler's behavior may be explained more widely in terms of a single choice of plain sobriety (A) over plain drunkenness (B); the social drinker presumably achieves a still

higher value than the teetotaler by a mixture of drinking and abstention (A*). In economic terms, this increase in value is achieved in the same way a consumer achieves a higher value by buying meat and potatoes (A*) rather than only meat (A) or only potatoes (B).

Maximization and perception. In Aristotelian terms, to explain behavior via the abstraction of patterns is to perceive a broader final cause of that behavior. Perception per se, as opposed to self-control, requires only a consistent discriminative act. Thus, a person could perceive a pattern in another person's behavior or in a story and consistently verbally discriminate that pattern from less valuable ones. By this reasoning it would also be possible for people to discriminate more valuable patterns from less valuable ones in their own previous behavior. A person could make the discrimination (as Alcoholics Anonymous members may say, "I wish I could be a social drinker," or as a workaholic may say, "I wish I could take a day off") but still not be able to bring the relevant behavior into line. Similarly, a physician could come to fully understand a higher value implicit in a healthy diet and still consistently overeat.

The Gestalt psychologists propounded a principle of perceptual organization called "common fate" (Köhler, 1947). Common fate is essentially the common function of a series of elements of a pattern. Acting much like Gibson's (1966) "affordances," common fate categorizes discriminative acts. Assuming, for example, that some mixture of drinking and sobriety of the teacher at wine-and-cheese parties (Pattern A*) elevates value above that of strict sobriety (A) or repeated drinking (B), the very increase in value (the common fate) may organize the elements of A* into a perceptible unit. For humans, subtle discriminations among valuable patterns are themselves valuable because the discrimination often precedes self-control. If the very first few acts of self-control are considered to be purely discriminative acts (like saying, "Here is an example of what I would like to do"), then perception may be said to be necessary for self-control. But perception is not the same thing as self-control, as we know so well from the many people who want to stop smoking or to eat heathy diets but who in fact repeatedly start the pattern (perceive the value) but do not bring their long-term behavior into line. Of course, if their behavior does come into line, their perception is strengthened and may thereby be extended to other acts.[5]

The difficulty of maximization. Self-control is difficult not because we are prone to make different kinds of errors (as the billionaire conference speaker suggested) but for two reasons: First, as patterns become more abstract and extended over time, they become more difficult to perceive. Common fate weakens. The magnitude of the difference in value between a workaholic pattern and a normally balanced life is less than that between a slothful life and a workaholic pattern. Second, even if perceived, the more elaborate patterns require the maintenance of wide temporal horizons (shallow discount functions) in the presence of strong immediate reinforcers. The teetotaler who takes one drink and the workaholic who takes one day off from work both face an awful conflict. They each are in a sense tossing the dice with regard to the future. They perceive a higher value in a pattern more elaborate than the one in which they are currently engaged but the teetotaler may slip back to alcoholism instead of becoming a moderate drinker, and the workaholic may slip into laziness instead of achieving a balanced life. The issue is up in the air (for both subject and observer) until future behavior settles it.

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[5] The action of common fate (or common function) is still clearer in the social sphere. Cooperation in prisoner's dilemma games depends on perception of common interest. Where common interest is clearly perceived, cooperation is the norm. Most people if offered $1,000 for themselves alone or $2,000 to be shared among their immediate family (of, say, three people) would take the $2,000. Lottery winners frequently put family members' names on the ticket, reducing their own share by a half or a third in order to save 1% or 2% in taxes. Such behavior depends on perception of common interest with their family (and lack of perception of common interest with their government).

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Received December 31, 1994
Final acceptance June 7, 1995