strength and stiffness in tension, high energy absorption, and electrical and thermal conductivity. The low density of these fibers would provide further weight savings.

Carbon nanotubes can also act as a nucleating agent for polymer crystallization and as a template for polymer orientation (*12*). No other nucleating agents are as narrow and long as a single-wall carbon nanotube. The tensile strength of a poly(vinyl alcohol) film tripled with the addition of 1 wt % of single-wall carbon nanotubes (*13*). Similarly, incorporation of 1 wt % of carbon nanotubes in polyacrylonitrile increased the tensile strength and modulus of the resulting carbon fiber by 64% and 49%, respectively (*14*). Polyacrylonitrile/carbon nanotube composites have good tensile and compressive properties. Next-generation carbon fibers used for structural composites will thus likely be processed not from polyacrylonitrile alone but from its composites with carbon nanotubes.

If processing conditions can be developed such that all carbon nanotube ends, catalyst particles, voids, and entanglements are eliminated, this would result in a continuous fiber with perfect structure, low density, and tensile strength close to the theoretical value. Such a carbon nanotube fiber could have 10 times the specific strength of the strongest commercial fiber available today. However, many challenges have to be overcome to achieve this goal.

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ECONOMICS

Homo economicus Evolves

Economic models can benefit from incorporating insights from psychology, but behavior in the lab might be a poor guide to real-world behavior.

Steven D. Levitt and John A. List

The discipline of economics is built on the shoulders of the mythical species *Homo economicus*. Unlike his uncle, *Homo sapiens*, *H. economicus* is unswervingly rational, completely selfish, and can effortlessly solve even the most difficult optimization problems. This rational paradigm has served economics well, providing a coherent framework for modeling human behavior. However, a small but vocal movement in economics has sought to dethrone *H. economicus*, replacing him with someone who acts "more human." This insurgent branch, commonly referred to as behavioral economics, argues that actual human behavior deviates from the rational model in predictable ways. Incorporating these features into economic models, proponents argue, should improve our ability to explain observed behavior.

The roots of behavioral economics date back to Adam Smith, who viewed decisions as a struggle between "passions" and an "impartial spectator"—a "moral hector who, looking over the shoulder of the economic man, scrutinizes every move he makes" (*1*). Simon's (*2*) pioneering analysis of bounded rationality represents an early attempt to incorporate cognitive limitations into economic models, as did later work on bias and altruism (*3*–*5*).

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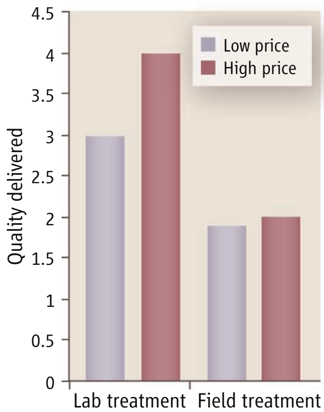
The watershed for behavioral economics came in the 1970s. Kahneman and Tversky carried out the landmark study on nonstandard preferences (*6*), or what has become known as "loss aversion" or the "endowment effect," i.e., that losses loom larger than gains in decision-making. In a similar spirit, models of social preferences, such as human reciprocity, inequity aversion, and altruism (*7*–*9*), and modeling of temporal decision-making (*10*) have substantially influenced economic research. These theoretical approaches are buttressed by an entire body of empirical evidence drawn from laboratory experiments that lends strong support to their critical modeling assumptions and findings.

Most of this research eschews a narrow conception of rationality, while continuing to embrace precisely stated assumptions that produce a constrained optimization problem. A less "scientific," and in our view less productive line of research in this area approaches the problem from the opposite direction: Observing an unexpected pattern of behavior (e.g., lower stock markets on rainy days in New York City), one looks for a psychological theory consistent with that behavior (in this case, seasonal affective disorder). Given the wide array of psychological explanations from which to choose, however, a researcher undertaking such a task has virtually unlimited freedom to explain any observed behavior ex post facto.



Selfish subjects. Quality as a function of price offered for sports trading cards of different quality (*13*). **(Left)** Results of offering high ($65) and low ($20) prices in a laboratory setting. **(Right)** Results in a natural environment with the sellers unaware they were participating in an experiment. Dealers in the lab provide much higher quality on average for the same offer, and respond to generous offers in the lab by increasing the quality of the goods. This suggests that dealers behave far more selfishly in natural settings than in the lab.

Perhaps the greatest challenge facing behavioral economics is demonstrating its applicability in the real world. In nearly every instance, the strongest empirical evidence in favor of behavioral anomalies emerges from the lab. Yet, there are many reasons to suspect that these laboratory findings might fail to generalize to real markets. We have recently discussed (*11*) several factors, ranging from the properties of the situation—such as the nature and extent of scrutiny—to individual expectations and the type of actor involved. For example, the competitive nature of markets encourages individualistic behavior and selects for participants with those tendencies. Compared to lab behavior, therefore, the combination of market forces and experience might lessen the importance of these qualities in everyday markets.

Recognizing the limits of laboratory experiments, researchers have turned to "field experiments" to test behavioral models (*12*). Field experiments maintain true randomization, but are carried out in natural environments, typically without any knowledge on the part of the participant that their behavior is being scrutinized. Consequently, field experiments avoid many of the important obstacles to generalizability faced by lab experiments.

Some evidence thus far suggests that behavioral anomalies are less pronounced than was previously observed in the lab (*13*) (see the figure). For example, sports card dealers in a laboratory setting are driven strongly by positive reciprocity, i.e., the seller provides a higher quality of good than is necessary, especially when the buyer offers to pay a generous price. This is true even though the buyer has no recourse when the seller delivers low quality in the lab experiment. Yet, this same set of sports card traders in a natural field experiment behaves far more selfishly. They provide far lower quality on average when faced with the same buyer offers and increase quality little in response to a generous offer from the buyer.

Other field data yield similar conclusions. For example, farm worker behavior is consistent with a model of social preferences when workers can be monitored (*14*). Yet, this disappears when workers cannot monitor each other, which rules out pure altruism as the underlying cause. Being monitored proves to be the critical factor. Similar data patterns are observed in work that explores the endowment effect (*15*).

Stigler (*16*) wrote that economic theories should be judged by three criteria: generality, congruence with reality, and tractability. We view the most recent surge in behavioral economics as adding fruitful insights—it makes sense to pay attention to good psychology. At the very least, psychological insights induce new ways to conceptualize problems and provide interesting avenues of research. In their finest form, such insights provide a deeper means to describe and even shape behaviors. One important practical example involves savings decisions, where it has been shown that decision-makers have a strong tendency to adhere to whatever plan is presented to them as the default option, regardless of its characteristics. With this tendency in mind, Madrian and Shea (*17*) worked with a Fortune 500 company to change the default option for the firm's retirement plans, dramatically influencing asset allocations. The changes in behavior induced by changing default rules dwarf more "rational" approaches to influence choice such as information provision or financial education.

Behavioral economics stands today at a crossroads. On the modeling side, researchers should integrate the existing behavioral models and empirical results into a unified theory rather than a collection of interesting insights, allowing the enterprise to fulfill its enormous potential. To be empirically relevant, the anomalies that arise so frequently and powerfully in the laboratory must also manifest themselves in naturally occurring settings of interest. Further exploring how markets and market experience influence behavior represents an important line of future inquiry.

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MEDICINE

Combating Impervious Bugs

Host and bacterial proteins essential for bacterial survival offer new avenues for developing nonantibiotic-based treatments for infections.

Richard P. Novick

Staphylococcus aureus has always been a serious human pathogen, and during recent decades it has become more serious owing to its acquisition of antibiotic resistance. In the past few years, a new strain of methicillin-resistant *S. aureus* (MRSA), known as USA300, and its close relatives, have emerged that are not only resistant to antibiotics but are more virulent and highly contagious. MRSA is presently spreading throughout the world, in hospitals and also in community settings where people are in close contact (*1–3*). Indeed, in the United Sates, MRSA infections now account for more deaths each year than AIDS (*4*). But two reports, by Corbin *et al.* on page 962 in this issue (*5*), and by Liu *et al.* in *Science Express* (*6*), are cause for some cautious optimism about new therapeutic approaches to treat such infections.

Both studies describe possible strategies for interfering with the ability of *S. aureus* to thwart attacks that are mounted by the immune system during infection. Bacteria defend against lethal reactive oxygen species (ROS) produced by neutrophils, immune cells that are mobilized to sites of infection. Corbin *et al.* show that calprotectin, a well-known mammalian calcium-binding protein, chelates manganese (Mn^{2+}), which the bacterium requires for growth and for detoxifying ROS. Liu *et al.* report that certain cholesterol-lowering drugs have an entirely unexpected activity against *S. aureus*—blocking synthesis of staphyloxanthin, the pigment that imparts the organism's characteristic color (aureus means "golden" in Latin) and also chemically detoxifies ROS.

Staphylococcal infection is an especially serious health threat in individuals with weakened immune systems, impaired circulation (as with diabetics), and surgical wounds. In deep-tissue sites, staphylococci can be life-threatening, even in otherwise healthy individuals. Staphylococcal abscesses form when the host immune system recognizes certain bacterial products, including cell wall components

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