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**ON THE SURFACE**, the six lab rats quaffing root beer and tonic water were resolving a famous but rather unimportant textbook problem. More profoundly,

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they were demonstrating the presence of economic rationality in a place where it had hitherto not been suspected: inside their tiny rat brains.

The rational rats were being assisted by Raymond Battalio and John Kagel, who in the early 1970s began to ask how intelligent animals really are. (Kagel and Battalio were no strangers to searching for rationality in unexpected places: Their early work showed that patients in long-term mental institutions were perfectly able to earn and spend “token” wages sensibly.) Kagel and Battalio used some well-established tools of experimental psychology but asked fresh questions, such as: Can rats plan, calculate, and make choices given wages, prices, and a budget?

Kagel and Battalio put each rat into an experimental box, about the size of a picnic basket, equipped with a little vending machine with a pair of levers that dispensed different drinks. The rats quickly learned that they could earn drinks by pressing on the levers, and with a week or two of practice were familiar with all the details of how much each lever produced.

Kagel and Battalio then changed “prices” or “income” to see how the rats

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responded. They changed relative prices by adjusting the machine to dispense less drink per press of the lever while leaving the other lever unchanged; they set income by limiting the total number of lever presses in each session.

In case you are feeling sorry for the poor rats, be assured that economists are the best possible experimenters. Instead of dissecting the rats or testing toxins on them, Kagel and Battalio plied them with root beer and regularly got a vet, Ray Battalio's neighbor, to check on their well-being.

After satisfying themselves, and a growing number of once-skeptical economists, that the experiments were meaningful, Battalio and Kagel and their colleague Carl Kogut decided to try to unlock a hundred-year-old mystery. They gave their rats the choice of two drinks, each of which had its own lever. One was root beer, a longtime favorite with your average lab rat. The second was water flavored with quinine—tonic water, in other words. Rats don't like its bitter taste, but the researchers had made the servings of quinine solution much more generous than the servings of root beer.

Think yourself into the rat's position for a moment. You're thirsty. The root beer is delicious but it's expensive, so you compromise, slaking your thirst on

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the nasty quinine solution but also enjoying some root beer. You don't press the lever at random.

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Now, what happens when the price of quinine goes up a little—that is, when the servings become less generous? To an experimental psychologist, the answer is simple. You're getting less bang for your buck from the quinine lever, so you should press it less frequently. That seems sensible. But it happens to be irrational, as an economist could attest and a rat instinctively grasps.

As a smart rat, you drink more quinine when it gets more expensive, as long as the servings are still larger than those of the root beer. That's because you're responding to your budget as well as the price. The total consumption of liquid—root beer plus quinine water—is what's keeping you alive. Quinine water is still cheaper than root beer, and because the experimenters have made you poorer by raising the price of quinine, you are obliged to drink less of the expensive root beer and slake your thirst by consuming even more of the nasty quinine water, which remains relatively cheap.

Battalio, Kagel, and Kogut showed, quite convincingly, that this is exactly what rats do. By consuming more quinine when the price of quinine rose, the rats had solved a conundrum that went back to 1895—do “Giffen goods” exist? A Giffen good is a good like the quinine water, one that is such a wretched necessity for the poor that when the price rises, demand rises too, because the price rise creates more poverty and the poverty creates more demand. As an impoverished economics student, I imagined baked potatoes, my staple diet, might be Giffen goods: If the price of potatoes rose, I would not be able to afford the cheese or tuna-mayo fillings and would buy larger potatoes instead. Over the years, economists had suggested, but never proved, that foods ranging from potatoes during the Irish famine to noodles in rural China are Giffen goods. Battalio, Kagel, Kogut, and the rats provided the first incontrovertible example: quinine water.

Yet the real significance of Kagel and Battalio's experiments was not to settle obscure Giffen goods wagers in economics departments across the world. It was to establish that the rats showed surprising intelligence and responded to their full range of options, including the way that their present choices would restrict their future choices. Given the chance, even rats can be rational.