Are Humans Irrational and Difficult to Educate? On the Evidence Supporting Libertarian Paternalism (Postprint)

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Abstract

Based on psychological research, libertarian paternalists contend that human cognition possesses deeply ingrained systematic flaws that individuals cannot easily overcome, and that these flaws cannot be avoided or eliminated through education. Consequently, they advocate leveraging external experts to "nudge" people' s behavior toward the correct direction. However, from the perspective of ecological rationality, choices made in accordance with what libertarian paternalists term cognitive biases do not necessarily lead to undesirable outcomes, while choices made according to the rational methods endorsed by libertarian paternalists do not necessarily yield ideal outcomes. This paper analyzes the evidence employed by libertarian paternalists to support nudging and reveals that: (1) such evidence originates from certain researchers' narrow definition of "what constitutes rationality," thereby misunderstanding the essence of human rationality; (2) they selectively report research findings while disregarding evidence contrary to these results. Through this analysis, we argue that the libertarian paternalist assertion that "humans are irrational and difficult to educate" is overly presumptuous and biased. Investing in education to teach individuals how to skillfully and astutely manage risk is not only feasible but also represents a more sustainable and effective solution as an alternative to nudging.

Full Text

Are Humans Irrational and Hard to Educate? On the Evidence for Libertarian Paternalism

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Abstract

Based on psychological research, libertarian paternalists argue that human thinking suffers from systematic flaws that are deeply entrenched and difficult to overcome through education. They therefore advocate guiding people' s behavior in desirable directions through "nudging" by external experts. However, from the perspective of ecological rationality, choices made according to so-called cognitive biases do not necessarily lead to poor outcomes, while choices made according to so-called rational methods may not necessarily lead to ideal outcomes. Our analysis of the evidence used to support nudging reveals that: (1) it stems from researchers' narrow definitions of rationality and misunderstands the nature of human rationality; and (2) it selectively reports research findings while ignoring contradictory evidence. Through this analysis, we argue that the libertarian paternalist claim that "humans are irrational and hard to educate" is overly sweeping and biased. Investing in education to teach people how to skillfully handle risk is not only feasible but also represents a more sustainable and effective solution than nudging.

Keywords: nudge, ecological rationality, risk, uncertainty, heuristics, framing effect, probability learning

Libertarian paternalism is a social governance philosophy that holds that authorities should guide people' s choices and behaviors benevolently, like parents guiding their children, while preserving freedom of choice and avoiding coercion. Its goal is to protect citizens by helping them avoid poor decisions and behaviors resulting from reasoning errors, behavioral inertia, and flawed intuitions. To achieve this, libertarian paternalists advocate using "nudges" to influence behavior—methods that affect decisions without obvious reward-punishment mechanisms or coercive force.

For example, in many countries women over 50 receive appointment letters for mammography screening. This default appointment exploits our behavioral inertia—women may not actively register or cancel the given appointment. Moreover, these letters and accompanying brochures often mention that early mammography screening can reduce breast cancer mortality by 20%, which constitutes a second nudge that exploits most people' s limited understanding of statistical information. Mammography screening reduces the number of women who die from breast cancer (within 10 years) from 5 to 4 per 1,000, representing an absolute risk reduction of 1/1000. However, to highlight effectiveness, promotional materials only provide the relative value of 20% risk reduction [**?**, **?**].

This example illustrates the difference between nudging and education. Nudging (such as appointment letters) aims to change behavior (increase screening participation) rather than enhance understanding of the screening itself. As a result, compared to Russian women who are not nudged in this way, women in

EU countries know less about the benefits of screening [**?**, **?**, **?**, **?**]. In contrast, education aims to enlighten the public, requiring governments to adopt various measures to help citizens understand risk information and communicate it transparently, enabling them to make informed decisions themselves. However, this may lead to behaviors contrary to nudging goals: if the public knows that only a minority of women benefit from mammography screening while most suffer harms (including time and money costs, potential false positives, and psychological burdens from knowing results), many women may choose not to participate.

The central argument of this paper is that while it is commendable to guide people benevolently by leveraging their cognitive biases, nudging is not the only way to help people. More importantly, we should consciously invest in education to teach people how to skillfully handle risk and make wise decisions. While nudging is defensible, the libertarian paternalist approach of making it the sole and extreme solution, along with the evidence behind it, is questionable.

1 Nudging and Libertarian Paternalism

In the research literature, nudging is often conflated with libertarian paternalism. In our view, nudging is merely a label for non-coercive methods of guiding public behavior. Some of these methods existed long before the concept of nudging was introduced, such as the etched black flies on airport urinals to reduce splashing and the striped patterns on Chicago highways to remind drivers to slow down [**?**, **?**]. However, since Thaler and Sunstein [**?**] published *Nudge*, almost all behavior-influencing measures have been rebranded as nudges, making the concept overly broad. Regarding libertarian paternalism, we adopt Rebonato' s [**?**] definition:

> Libertarian paternalism is a set of interventions that utilize people' s stable cognitive biases to overcome these very biases, with the goal of guiding people toward rational choices they themselves would endorse.

The core ideas are as follows:

Goal. A benevolent "choice architect" designates the best choices and behaviors for people.

Manipulation. Without incentives, coercion, or education, choice architects use various nudges to steer behavior in the defined good direction.

Justification. To justify nudging over education, libertarian paternalists appeal to psychological research claiming that people systematically lack rationality and cannot escape their cognitive limitations.

Among these three points, the last is particularly important for libertarian paternalists. Ariely [**?**, **?**] summarized: "We are not only irrational, but predictably irrational." What are these irrationalities? Thaler and Sunstein [**?**] explained: "People do not have rational expectations about their own behavior,

cannot make predictions consistent with Bayes' theorem, use heuristics that lead them to make systematic errors, exhibit preference reversals, and make different choices about the same problem merely because of different wording" (p.176).

Based on this, Thaler and Sunstein humorously suggested that humans are far from the shrewd *Homo economicus* imagined by economists, but more like the bumbling Homer Simpson from the cartoon. This metaphor and its underlying idea have been influential because they directly challenge the core of neoclassical and other liberal economics. For example, in *Against Autonomy*, legal philosopher Sarah Conly argues that the famous liberal economist John Stuart Mill "failed to appreciate the role of human psychology in economic behavior as fully as we do now" (p.8), and that "the existence of cognitive defects does suggest the need for different types of legislation···including mandatory paternalistic legislation, because such laws can force people to do what is good for them" (p.2-3). In "Paternalism and Cognitive Bias," philosopher J.D. Trout [**?**] claims: "Our review of the literature on cognitive bias will show that they are almost as stable, persistent, and widespread as muscle reflexes" (p.396), and that "the Enlightenment view of human nature is a serious misjudgment." Similarly, behavioral economist Richard Thaler [**?**] asserts: "Cognitive illusions should be considered the general rule rather than the exception" (p.4). Psychologist Daniel Kahneman [**?**] also claims: "The messiness of democratic institutions is inevitable, partly because the availability and affect heuristics that influence citizens' thoughts and attitudes are inevitably biased, even when they point in the right direction in most cases" (p.145).

Despite these sharp statements, their intention is not to question and overturn the *Homo economicus* hypothesis. Instead, libertarian paternalists unreservedly accept the axioms of decision theory as the norm for rational behavior, condemning and mocking the public' s inability to achieve this ideal. In their view, using "wise man" (*Homo sapiens*) to describe humans is inappropriate; we should instead use "irrational man" (*Homo irrationalis*).

The argument that humans are irrational and hard to educate is implicitly derived through three analogies: visual illusions, the reptilian brain (the most primitive part of the brain inherited from reptiles), and "System 1" —the supposedly ancient, evolutionarily old system that relies on heuristics and intuition rather than statistics and logic. These analogies equate cognitive errors with biological determinism, implying that attempts to educate people out of these errors are doomed to fail.

In short, libertarian paternalists argue that cognitive defects are both universal and nearly irremediable. While they do not explicitly state the latter, without it they would have to explain why they prefer nudging over education. In this paper, we will argue that: (1) the evidence for systematic human irrationality is far from clear, as their conclusions are based on (a) narrow logic-based rationality standards that misunderstand the ecologically adaptive nature of rationality, and (b) confirmation bias—selectively citing evidence to support their claims; (2) there is no clear empirical evidence that people cannot be educated;

on the contrary, research shows that children, adults, and experts can learn correct statistical thinking through appropriate numerical or visual representations; educating people to become risk-savvy is an effective alternative to nudging [**?**, **?**]; and (3) implementing libertarian paternalism requires choice architects who know what optimal choices are, presupposing that they are not plagued by cognitive biases like us and have no conflicts of interest with us, yet research suggests such experts and policymakers likely do not exist.

2 Evidence for Systematic Deviations from Rationality

Here we limit our analysis to three so-called stable cognitive errors cited by Thaler and Sunstein [**?**, **?**]: (1) people make different choices based on problem description wording, i.e., the framing effect; (2) people cannot make predictions consistent with Bayes' theorem, i.e., the base rate fallacy; and (3) people use heuristics that lead them to systematic errors, with the underlying assumption that judgments based on statistics and logic are always more accurate than those based on heuristics and intuition.

2.1 Framing Effects

Framing effects occur when people make different choices between two supposedly "logically equivalent" descriptions. Framing effects are considered inconsistent with rational behavior because they violate the principle of description invariance, which is "a necessary condition for any normative decision theory" [**?**, **?**, **?**]. Framing effects are crucial for libertarian paternalism because they imply that besides paternalism, there is no universal behavioral norm. Let us start with the classic example of framing effects:

"The glass is half full."
"The glass is half empty."

Do different descriptions affect people? In one experiment, a full glass (A) and an empty glass (B) were placed on a table. The experimenter asked participants to pour half the water from glass A into glass B, then place the "half-empty" glass on the table edge. Most participants chose glass A [**?**, **?**]. This and similar experiments show that in many cases, the specific wording of a request carries redundant information. In this experiment, the glass' s past state served as a reference point, leading most people to intuitively believe the experimenter meant the half-empty glass was the one that had been half-emptied. The ability to listen carefully and understand others to reduce task uncertainty is a form of social intelligence, not an irrational bias. For participants in this experiment, they needed to make pragmatic rather than logical inferences.

More broadly, analyzing the relationship between mind and environment (here, listener and speaker) is precisely what ecological rationality embodies [**?**, **?**], while descriptive equivalence is a form of logical rationality. As a normative decision criterion, logical rationality cannot guarantee correct interpretation of given information.

Here is an example of framing effects from libertarian paternalists [?, ?, ?, ?, ?]: Suppose you have heart disease and are considering risky heart surgery. The doctor describes postoperative outcomes in two ways:

- Five years after surgery, 90% of patients survive.
- Five years after surgery, 10% of patients die.

Thaler and Sunstein [?] argue that if people change their choices due to different doctor descriptions, it shows they are influenced by framing and cannot maintain description invariance. Citing only one study, they assert that in countless experiments, "people make completely different responses to descriptions with identical content" (p.39), then conclude: "Framing works because people are often unconscious, passive decision-makers" (p.40).

A review article covering 40 studies [?, ?, ?, ?, ?] found that participants shown survival descriptions were indeed more likely to accept surgery than those shown mortality descriptions. However, this framing effect only occurs under specific conditions of surgical treatment. When treatment methods are changed to medication or immunotherapy, no evidence of the above framing effect exists. Studies of decision-making behavior in real rather than hypothetical situations yield the same results.

Let us analyze the "survival/death" framing problem using the same method as the "half-full/half-empty" glass problem—not considering logical structure in isolation, but considering the patient' s purpose. Neither the 90% survival rate nor the 10% mortality rate provides sufficient information for patient decision-making, because patients do not know the survival or mortality rates without surgery. Although this reference point is crucial for deciding whether to have surgery, the information does not appear in the problem description. Therefore, patients must rely on their social intelligence to make educated guesses. As mentioned earlier, language descriptions have ecological effects: speakers can choose wording to convey information about reference points, and listeners can capture this information. Research shows that if the reference point is lower (patients without surgery have lower survival rates), 80%-94% of doctors choose to communicate using survival framing; but if the reference point is higher (patients without surgery have higher survival rates), survival framing is rarely chosen [?, ?]. Thus, by choosing framing, doctors can convey information about which treatment is better, thereby giving implicit recommendations, and accepting doctor recommendations is also an appropriate choice for patients, not a cognitive bias.

Finally, let us discuss the famous Asian disease problem [?, ?]. A disease is expected to kill 600 people, and participants must choose between two treatment options. There are positive and negative framing descriptions. The positive (gain) framing is:

- If Program A is adopted, 200 people will be saved (risk-free option).
- If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no one will be saved (risky option).

The negative (loss) framing is:

- If Program C is adopted, 400 people will die (risk-free option).
- If Program D is adopted, there is a 1/3 probability that no one will die, and a 2/3 probability that 600 people will die (risky option).

Unlike the previous two tasks, this task includes a risky option. Many experiments show that when choosing under gain framing, most people prefer the risk-free option A; but under loss framing, most people prefer the risky option D. Because the positive and negative descriptions are logically equivalent, this result makes most people' s choices appear logically inconsistent.

However, careful examination of the wording reveals a strange feature: the outcomes of the risky options are fully specified, while the risk-free options are not. For example, the risk-free option states "200 people will be saved"without adding "400 people will not be saved." Logically, the missing information does not affect the overall structure of either framing, but for intelligent people, missing information is meaningful. Not providing complete information may be precisely why framing effects occur and how libertarian paternalists accomplish "nudging." Reviewing the surgery problem above, you will find that the two risk-free options in the Asian disease problem correspond to the survival/death framing in the surgery problem, with similar 暗示 effects on participants. Consistent with this ecological (rather than logical) analysis, research shows that framing effects in the Asian disease problem are mainly caused by risk-free options rather than risky options [**?**, **?**]. When researchers fully specified the risk-free options, framing effects disappeared [**?**, **?**, **?**, **?**]. This suggests that people tend to assume option descriptions reveal the speaker' s intentions, contain implicit recommendations, and make choices accordingly. Once uncertainties in the information are clarified, framing effects vanish.

The above ecological analysis of framing effects does not apply to all framing effects. Nevertheless, these analyses sufficiently demonstrate that description invariance is not always a reasonable criterion for evaluating rational behavior. Framing effects are considered violations of description invariance, but their causes may be strategic interaction, implicit recommendations, and other forms of social intelligence. From the perspective of ecological rationality, speakers often need to rely on wording to implicitly convey relevant information and make recommendations, while listeners need to capture this information and choose accordingly. In fact, understanding implied meaning requires higher cognitive demands than following logical rules like description invariance. After all, computers can effortlessly master logical rules but still cannot understand natural language well. These behaviors result from people following intuition but are often misinterpreted as logical fallacies. When intuition makes people smarter than logic, is it necessary to nudge them away from so-called "logical fallacies" ?

We elaborate on research questioning the logical norm of description invariance because such research is rarely noticed or is intentionally ignored by libertarian

paternalists. This phenomenon can be called "bias in bias research" : focusing only on evidence that appears to support their view (that people systematically deviate from rationality) while ignoring research that finds no bias or disagrees with their rationality standards. For example, to our knowledge, McKenzie and colleagues' research on framing effects has never been mentioned in libertarian paternalist writings or in most behavioral economics articles discussing framing effects as violations of rationality. This bias also exists in research on other so-called cognitive illusions [**?**, **?**, **?**, **?**, **?**]. Let us provide one final example.

"One of the most important and irrefutable findings in behavioral psychology is that people are overconfident in their judgments" [**?**, **?**, **?**, **?**]. Such absolute claims occur frequently, displaying these authors' own overconfidence about the "overconfidence"phenomenon. However, a slightly more careful review of relevant psychological literature reveals a quite different picture. First, several possibly related phenomena are all labeled as overconfidence. Take "calibration error in subjective probability" —the so-called irrefutable finding. Since the mid-1990s, research has shown that this calibration error does not come from systematic errors in the public but is an artificial statistical error produced by researchers' misunderstanding—mistaking a non-systematic error for a systematic one [**?**, **?**, **?**, **?**, **?**]. The fundamental cause is the common misunderstanding of the statistical phenomenon "regression to the mean" —incorrectly attributing results from imperfect correlation to systematic phenomena. The same error appears in classic research supposedly proving that people systematically overestimate small risks but underestimate large risks [**?**, **?**, **?**, **?**]. Previous and current research shows that the main cause of this calibration error is also the statistical phenomenon of regression to the mean, not systematic bias in participants [**?**, **?**, **?**, **?**]. A second phenomenon also called overconfidence comes from experiments where participants answer questions, and the difference between their average confidence and final accuracy shows overconfidence. Research indicates this result may stem from researchers' non-representative (i.e., selective) sampling of questions. A meta-analysis of 130 studies showed that when representative sampling is conducted, this overconfidence phenomenon disappears [**?**, **?**, **?**, **?**].

These studies do not claim that people are never or should never be overconfident. If you work in an industry that makes money by predicting exchange rates or stock trends, you are usually and need to be overconfident; otherwise, no one would buy your advice. But functional overconfidence is different from innate cognitive illusions. In libertarian paternalist writings, we see no discussion of research showing that most people have non-systematic (rather than systematic) biases, and sparse citation of literature that disagrees with their views.

2.2 Bayes' Theorem

Thaler and Sunstein [**?**] claim that people "cannot make predictions consistent with Bayes' theorem."This assertion can be traced to Kahneman and Tversky [**?**], who rejected earlier conclusions that people are approximate but conservative Bayesian thinkers, arguing that "humans are clearly not conservative Bayesian

thinkers, but are not Bayesian at all" (p.450). Unlike description invariance, Bayes' theorem is strictly derived from probability axioms, making it a true test of human rationality. For libertarian paternalists, if conditions for applying Bayes' theorem are met but people' s predictions systematically deviate from it and they cannot learn from their mistakes, this is excellent evidence that their behavior fails rationality standards. Here, we cannot comprehensively review the vast psychological literature on Bayesian reasoning but briefly point to research with conclusions quite different from libertarian paternalists.

Two paradigms study Bayesian reasoning: probability learning and text problems. In probability learning, people learn probabilities from experience, then their judgments are tested for consistency with Bayes' theorem. Many cognitive scientists using this paradigm conclude that people' s judgments are roughly consistent with Bayes' theorem [**?**, **?**, **?**, **?**, **?**, **?**]. For example, Schooler and Anderson' s [**?**] research found that the principle of forgetting aligns with Bayesian reasoning. In "Bayesian Models of Cognition," Griffiths, Kemp, and Tenenbaum [**?**] argue that both unconscious low-level perceptual processes (like inferring object color and shape) and high-level cognitive processes (like language comprehension and categorization) conform to Bayesian models. In neuroscience, the idea that humans have a "Bayesian brain" [**?**, **?**] is widely influential. Behavioral economists always claim that fast, unconscious, and automatic judgments (so-called System 1) do not follow probability principles, but cognitive science research holds the opposite view.

The second paradigm provides participants with text problems where probabilities are presented numerically. There are two types of problems in this paradigm. In the first type, only base rate numbers are provided, such as 30 engineers and 70 lawyers among interviewees, then participants see a description of one person, such as someone with typical engineer characteristics. On average, people' s estimates of this person being an engineer are unrelated to the base rates of engineers and lawyers [**?**, **?**]. This and similar results are considered examples of base rate fallacy, "perhaps one of the most obvious examples where our intuition deviates from normative prediction theory" (p.243).

However, as every professional statistician knows, rationally applying Bayes' theorem requires more than just inputting numbers into formulas, including testing many prerequisite assumptions. A key assumption about the role of base rates in Bayesian calculation is that the described person is randomly selected from the given population. If not, we cannot assume inferences about them correlate with base rates. Nevertheless, some text problems, including the famous "Tom W." problem [**?**, **?**], do not provide random sampling information. Other problems, like the engineer-lawyer problem above, claim random sampling but actually do not, because the descriptions given to participants are fabricated rather than truly random sampling results [**?**, **?**, **?**]. In the engineer-lawyer experiment, if participants are told in advance that each card in a box contains a description consistent with a person' s identity and they can randomly draw a description from the box, they largely do not ignore base rates [**?**, **?**, **?**, **?**, **?**].

Therefore, ordinary people may be more sensitive to the concept of random sampling than researchers who accuse them of irrationality.

In the second type of text problem, researchers provide not only base rates but also hit rates and false alarm rates, asking participants to estimate posterior probabilities; the taxi problem [?, ?] is one example. Consistent with Thaler and Sunstein' s claims, there is stable evidence that people cannot make predictions consistent with Bayes' theorem in this task. However, an important condition produces this phenomenon: probabilities (like hit and false alarm rates) are presented as conditional probabilities. The reason people cannot make Bayesian predictions lies not only in human thinking but also in the ecological environment of the problem—how information is presented. Most people are not good at processing conditional probabilities. However, if information is presented as natural frequencies, the proportion of people who can reason according to Bayes' theorem increases substantially [?, ?, ?, ?, ?, ?, ?, ?]. This applies to both professionals and non-professionals. For example, based on conditional probabilities, only 21% of 160 gynecologists could accurately infer the posterior probability that a woman with a positive mammogram has breast cancer. The same gynecologists, after learning how to convert conditional probabilities into natural frequencies, could infer posterior probabilities consistent with Bayes' theorem [?, ?]. A Cochrane systematic review [?, ?] also concluded that health practitioners and consumers understand natural frequencies more easily than probabilities. Natural frequencies also help judges, lawyers, and law students understand what DNA matching means [?, ?, ?, ?, ?], especially when using graphical representations of frequencies [?, ?, ?, ?, ?].

Throughout the complete psychological literature, the claim that people universally cannot reason in Bayesian ways is unsupported. Instead, ecological analysis shows that certain information presentation formats (like natural frequencies) help people reason in Bayesian ways, while others interfere, just as Arabic numerals facilitate division problems more than Roman numerals. Additionally, the cognitive science research mentioned earlier shows that fast, intuitive reasoning conforms to Bayes' theorem, refuting the System 1 view that unconscious, basic psychological processes do not follow probability principles.

Finally, are people truly unteachable as implied by the analogy between cognitive illusions and stable visual illusions? Research on gynecologists provides a negative answer: after just one lesson, most doctors can reason in Bayesian ways. But can people retain what they learn? A study titled "Teaching Bayesian Reasoning in Less Than Two Hours" [?, ?] showed that three months after training participants to solve problems using natural frequencies, they showed no usual signs of forgetting, but when taught to embed probabilities into Bayes' formulas, forgetting occurred. Moreover, even children can make predictions consistent with Bayes' theorem. In a Beijing study, 135 children were asked over 1,000 Bayesian questions expressed in natural frequencies. Most sixth-grade children could accurately infer Bayesian posterior probabilities, one-third of fifth-graders could, and one-sixth of fourth-graders could [?, ?]. Unsurprisingly, when in-

formation was presented as conditional probabilities, no child could solve any problem. When using both natural frequencies and icons, German fourth-grade children could solve 60% of Bayesian problems, and even second-graders could solve 22% [?, ?, ?, ?]. Natural frequencies are now taught in German school mathematics curricula and are recommended by important, evidence-respecting medical societies such as the International Patient Decision Aid Standards Collaboration and the Healthcare Products Regulatory Agency (the UK' s Food and Drug Administration).

In summary, there is no evidence supporting the claim that people are poor at Bayesian thinking and can hardly escape their biases.

2.3 Heuristics

Heuristics play an important role in libertarian paternalist arguments, considered the main cause of thinking biases. People "use heuristics that lead them to systematic errors"[?, ?, ?]. According to them, people only make optimal choices by relying on logic or statistical methods rather than heuristics. However, logic and statistical methods can only define what is optimal in situations of risk, not uncertainty [?, ?, ?]. "Risk" refers to situations where all options, their possible consequences, and probabilities are known, such as textbook Bayesian problems or casino roulette; in these situations, long-term expected losses can be calculated, and heuristics are unnecessary. "Uncertainty" refers to real-world situations like investment and medical decisions; in these situations, not everything is known, accidents happen, and there is no way to define what is optimal. Under uncertainty, appropriately applying heuristics that seek robust rather than optimal solutions can help people make rational decisions. For Savage [?], the father of modern Bayesian optimization theory, even planning a picnic falls outside the scope of Bayesian theory.

For example, Thaler and Sunstein [?, ?] report that when investing his own retirement account, Harry Markowitz used not his Nobel Prize-winning mean-variance portfolio method but the 1/N heuristic. This simple heuristic distributes available assets equally among N options and stocks, without estimating many parameters required by mean-variance portfolio methods. DeMiguel, Garlappi, and Uppal [?] tested the 1/N heuristic' s performance in stock markets. Based on criteria including the Sharpe ratio, the 1/N heuristic outperformed the "optimal" mean-variance portfolio method in 6 of 7 investment problems. Therefore, in these uncertain situations, optimization calculations likely mean losses.

Whether to apply heuristics is actually an ecological rationality question: we should explore in which environments heuristics are more accurate than other methods. For instance, when markets are highly volatile, option numbers are huge, and sample sizes are small, 1/N may perform better than Markowitz optimization. Such analysis also helps explain inconsistent results when comparing 1/N and mean-variance portfolio methods [?, ?, ?, ?, ?, ?]. Research on eco-

logical rationality is detailed in three books: [?, ?, ?, ?], [?, ?, ?, ?], and [?, ?]. In short, ecological rationality research is based on mathematical analysis of Herbert Simon' s scissors analogy—how our cognitive system and environment together produce rational behavior. Two examples of this research paradigm can be found in [?, ?, ?, ?, ?]. Kahneman and Tversky often said heuristics are sometimes good and sometimes bad, but never specified when "sometimes" is. Ecological rationality research confronts this question directly and rejects the oversimplified claim that statistical optimization is always superior to heuristics.

Finally, behavioral economists generally believe that behavior violating rationality axioms (like relying on heuristics) provides theoretical foundation for paternalism because individual biases reduce collective (e.g., market) efficiency, which paternalism can help address. However, [?, ?] mathematically proved this view is wrong. Bounded rationality does not mean we must resort to paternalism.

3 The Argument That People Are Hard to Educate

As mentioned earlier, this argument is implicitly derived through three analogies: comparing cognitive illusions to stable visual illusions, the reptilian brain, and the supposedly ancient, "hard-to-educate" System 1 [?, ?, ?]. Evolutionary biologist Stephen Jay Gould [?] similarly argued that "our minds are not built to work by the rules of probability (for whatever reason)" (p.469). In a *Nature* article about nudging versus education, Richard Thaler was quoted: "Our ability to de-bias people is very limited" [?, ?, ?]. Dan Kahan stated: "Risk decision-making should be centralized to expert agencies insulated from politics" (p.1189-1190).

We have two responses. First, let us examine uncertain situations where optimal behavior cannot be clearly defined. Here, people will make wiser decisions if they consider information implied by framing or flexibly use heuristics. Therefore, there is no reason to teach people to abandon their intuitive wisdom for logically reasonable but practically ineffective actions. Second, consider risky situations. Here, statistical thinking is reasonable, but people cannot reason according to statistical rules. In such cases, people can learn but need appropriate tools like natural frequencies. [?, ?, ?, ?] taught the law of large numbers to adults and high school students in New Jersey. After only 25 minutes of training, participants' reasoning about everyday problems improved significantly. Similarly, [?, ?] described methods to improve intelligence through training. As anyone attending statistics teaching conferences knows, teaching statistical thinking is a feasible solution to help people overcome their deficiencies.

What truly can replace nudging is education. Education aims to enable children and adults to skillfully handle risk, use both statistical and heuristic thinking, and have the ability to judge the limitations and application domains of these two thinking modes. Unfortunately, most countries do not teach children mathematics involving uncertainty, only teaching deterministic mathematics like ge-

ometry and trigonometry.

Education is not within libertarian paternalists' considerations. They compare cognitive errors to stable, unavoidable visual illusions, so neglecting education is not accidental but a necessary consequence of believing this analogy is correct. However, this view ignores the fact that education is closely related to healthy behavior. For example, obesity is more prevalent among less educated people. Consider cancer, one of the most terrible diseases. As we have seen, even though cancer screening can only help a few people extend their lives while harming many through unnecessary biopsies and surgeries, people are still nudged into screening [**?**, **?**]. Since about half of cancers are caused by behaviors like smoking, obesity, lack of exercise, and alcohol consumption, education would be a better weapon against cancer. To make education more effective, we should teach children before they develop unhealthy habits of diet, alcohol, and smoking. Long-term education programs (including teaching children how to cook, enjoy healthy diets, and recognize corporate attempts to lure them into unhealthy behaviors) may save more lives than cancer screening and anti-cancer drugs [**?**, **?**, **?**].

4 The Assumption of Benevolent Choice Architects

Nudging people toward optimal choices requires choice architects who know what optimal choices are. However, this requirement contains a difficult contradiction [**?**, **?**, **?**]: on one hand, experts are believed to make the same cognitive biases as ordinary people; on the other hand, they are required to remain rational and understand people' s true needs and wants. For example, although Thaler and Sunstein jokingly claim they themselves are victims of bias, they continue writing as if unaffected by bias. Moreover, ideal, wise choice architects must not only clearly understand people' s true needs and preferences but also: (1) not engage in defensive decision-making, (2) understand scientific evidence, and (3) have no conflicts of interest with the public.

Let us examine healthcare, a field where libertarian paternalists believe governments, hospitals, and doctors should nudge people toward appropriate behaviors. Only when all three conditions are met can nudging benefit patients. However, in the US, Germany, and other Western countries, these conditions are often not met [**?**, **?**].

(1) **Self-defense.** Many medical practitioners practice defensive medicine; that is, to protect themselves from potential lawsuits, they recommend second-best rather than best options for patients. For example, a study of 824 Pennsylvania doctors found that 93% admitted practicing defensive medicine, including ordering unnecessary CT scans, antibiotics, and invasive procedures [**?**, **?**].

(2) **Innumeracy.** Many medical practitioners do not know how to interpret health-related statistics. For example, 70% to 80% of US family doctors do not understand what cancer screening survival rates mean for patients,

so they are easily misled into recommending screenings even when harms exceed benefits [?, ?, ?, ?, ?, ?].

(3) **Conflicts of interest.** Some medical practitioners pursue options that increase their own interests rather than optimal options for patients. This can be seen as a principal-agent problem: the agent (doctor, hospital) acts in their own rather than the principal' s (patient' s) interests. For example, an estimated one million American children receive unnecessary CT scans annually [?, ?]. CT scans are an important revenue source for medical institutions but expose a child to radiation equivalent to 100 chest X-rays. An estimated 29,000 cancer cases annually in the US are caused by approximately 70 million CT scans, and this number is increasing [?, ?].

These three biases in healthcare research are called the "SIC Syndrome" [Self-defense, Innumeracy, and Conflicts of interest; [?, ?]]. As long as this syndrome exists, choice architects may steer the public in directions not in the public' s best interest. Here are several examples.

Breast self-examination. Some choice architects believe women who do not perform monthly breast self-exams are risk-averse and suggest using loss rather than gain framing to nudge them; another nudging technique is telling women that most other women their age perform self-exams [?, ?, ?]. However, randomized clinical trials have not found evidence that self-examination reduces breast cancer mortality; instead, there is evidence of harm, such as increased breast biopsies [?, ?]. To this day, many women are guided to perform breast self-exams without being told there is no scientific evidence of benefit. Additionally, as mentioned above, some health agencies nudge women to attend breast cancer screening through appointment invitations but omit important study results: based on randomized clinical trials of over 500,000 women, [?, ?] found no evidence that breast cancer screening' s benefits outweigh its harms. Here, nudging seems to serve the interests of the massive breast examination industry rather than ensuring women make more informed decisions.

H1N1 vaccine. In 2009, with the swine flu outbreak, many governments purchased flu vaccines and drugs like Tamiflu following WHO recommendations. Given low vaccination rates in some countries, [?, ?, ?] suggested using nudges to increase response, such as sending people maps to local vaccination centers. When vaccines or drugs truly reduce deaths and serious complications, such nudges help. However, in Tamiflu' s case, years later there was still no evidence of its effectiveness. Although the *British Medical Journal* repeatedly asked Tamiflu' s manufacturer Roche to release relevant data, Roche refused (the journal published their correspondence on its website). Why did WHO encourage governments to stockpile antiviral drugs without any evidence? The answer appears to be conflicts of interest: many experts advising WHO had financial ties to pharmaceutical companies manufacturing these drugs [?, ?]. In this case, nudging helped pharmaceutical companies profit while nudgers and the nudged paid the price.

PSA testing. [**?**, **?**] proposed: "Doctors can describe options in specific frames to lead people to choose clearly better medical options, even if the option' s small risk of failure might scare some patients into choosing worse options" (p.180). This would be useful nudging if hospitals had no conflicts of interest with patients. Unfortunately, conflicts of interest often exist, with hospitals pursuing goals contrary to patients' interests. For example, many hospitals recommend routine PSA prostate cancer screening for men, despite the US National Cancer Institute warning that PSA testing' s harms may outweigh its benefits. By distorting statistics in advertisements, the renowned MD Anderson Cancer Center systematically misled men about prostate cancer testing benefits, just as Susan G. Komen's Red Ribbon organization deceived women about breast cancer screening [**?**, **?**, **?**, **?**, **?**]. As in the Tamiflu case, the path to scientific medical evidence is always blocked by a flood of distorted information. For example, a study based on representative samples from nine countries showed that over 90% of Europeans overestimated PSA and mammography benefits (by 10, 100, or even 200 times) or did not know what they were [**?**, **?**]. This is not because Europeans cannot think rationally, but because distorted statistics nudge them into blind faith in screening.

If choice architects have public welfare at heart, nudging may be effective. However, when policymakers make defensive decisions, are blind to risk information, or have conflicts of interest with the public (i.e., have SIC syndrome), nudging is far from an ideal choice.

5 Conclusion: More Risk-Savvy Citizens, Less Nudging

In this paper, we analyzed the scientific evidence used to justify nudging. Libertarian paternalists claim this evidence clearly shows people' s judgments systematically deviate from rationality and that educating people out of these biases is extremely difficult if not impossible. We focused on three so-called irrational cognitive biases: framing effects, base rate fallacy, and heuristic application.

Our conclusion is that the nudging-not-education argument relies too heavily on narrow logical rationality norms and suffers from confirmation bias. For each of these three "biases," deviations from rationality are overstated, and there is little evidence that people are unteachable.

Knowing this, what should we do? As argued earlier, a more effective alternative to blaming and nudging people is educating them to become risk-savvy. This requires people to have both statistical and heuristic thinking abilities and to be aware that the former applies to risky situations while the latter is indispensable under uncertainty. In most everyday problems, some risks are known while others are unknown, meaning both thinking tools are essential.

Libertarian paternalists believe no other governance approach can replace theirs. However, what if governments in power stop nudging due to other interests? What if tobacco and fast-food industries invest heavily to nudge people in opposite directions? Nudging without educating people means treating the public

like children. The adverse consequences of such behavior are especially evident today as human society enters the digital age. Since 2009, Google has personalized search results. Since then, when two people perform the same search, they no longer see the same results. By providing personalized result rankings, search engines show us what we like to see and what we have previously viewed. Rankings influence what we read, with about 90% of post-search clicks occurring on the first page of results, and one-third of clicks on the first result. Evidence shows that manipulating search result rankings for election candidates may affect democratic election outcomes [**?**, **?**]. This adds a new political dimension to the nudging discussion.

Teaching people to fish is better than giving them fish. We acknowledge that nudging advocated by libertarian paternalists is a useful strategy in some situations, but compared to nudging, a more sustainable solution is investing resources in teaching people how to skillfully handle risk. To be effective, education should start early, preferably before young people are tempted into smoking, eating junk food, and other unhealthy behaviors. Through education, the ability to correctly interpret risk and uncertainty in health, finance, and media reporting is becoming an essential survival skill in an increasingly complex world.

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Note: Figure translations are in progress. See original paper for figures.