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helping consumers choose the right health care plan

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Features

The White House Social and Behavioral Sciences Team Papers, Part 2

editors' note

In this, our fifth issue of *Behavioral Science & Policy (BSP),* we feature scientifically grounded articles that speak to an unusually broad range of urgent policy challenges.

American consumers have great difficulty figuring out which of the available health insurance policies is best for them, covering the services they need at the lowest cost. Saurabh Bhargava, George Loewenstein, and Shlomo Benartzi analyzed several thousand choices that were made by consumers on federal exchanges under the Affordable Care Act and determined that the current metallic labels for these plans (for example, *Gold, Silver,* and *Bronze*) are largely unhelpful to consumers, who frequently select an overly costly option. In a follow-up experiment, they found that participants made better insurance decisions when given a clear description of each plan based on anticipated usage. The findings imply that consumers would benefit from descriptions that clarify which health insurance options would cost the least for the medical services most likely to be used.

Although little empirical evidence documents widespread voter fraud in the United States, nearly half of Americans are concerned about the reliability and security of voting systems. Michael D. Byrne reviews the behavioral literature on voting systems and argues that existing federal guidelines are insufficient to guarantee the usability and accuracy of voting systems. He makes a compelling case for reforms to guarantee the integrity of elections and ensure that voting systems accurately capture the intentions of voters.

In the previous issue, we presented the first two reports from Behavioral Science & Policy Association working groups that were tasked with identifying opportunities for behavioral policy interventions at the federal level. These reports were commissioned in partnership with the White House Social and Behavioral Sciences Team (SBST) and were intended to support the work of the SBST and other federal agencies. In this issue, we present the final six reports. Many of their lessons can also be applied by city and state governments and by nongovernmental organizations in America and elsewhere.

In the first of these articles, Brigitte C. Madrian and colleagues describe applications of behavioral insights to financial decisions made by individuals and households. This group presents a number of specific recommendations to assist consumers in making better decisions concerning retirement, short-term savings, debt, government financial assistance, and tax payments. These proposed interventions address common behavioral biases while maintaining consumer autonomy.

The second report, by Ben Castleman and colleagues, focuses on applications of behavioral insights to education. The Education Team designed four promising interventions to promote participation in existing programs proven to improve prekindergarten, kindergarten through 12th grade, and postsecondary academic performance and greater parity among students from low-income families. These interventions are ready to be elaborated and tested.

Focusing on health care policy, George Loewenstein and his colleagues provide a detailed review of the literature on promising behavioral interventions that can influence the actions of individual patients and health care organizations to improve health outcomes at both an individual and a systemic level.

Fourth, Erez Yoeli and colleagues provide a research-based tool kit of behavioral science approaches that practitioners can use to enhance policies intended to promote energy and resource

conservation. These tools can help government agencies overcome people's limited attention and ability to process complex information, and they can provide motivation to act.

The fifth working group report takes on international development policy challenges. Christopher J. Bryan and his colleagues highlight two sources of difficulty in supporting development: people's limited attention and their tendency to focus disproportionately on present outcomes over future outcomes. The authors propose a number of promising interventions designed to overcome these limitations and improve the well-being of low-income individuals.

In our final report, Andrew Van de Ven and his team address two challenges for innovation policy. One is the need to help people whose full-time jobs are eliminated by new technologies. The other is that existing policies may underestimate the complexity of the innovation process and thus impede both the speed and the effectiveness of technological innovations that can enhance the economy and society. Although the authors do not propose specific recommendations, they do provide general guidelines for interventions based on relevant behavioral and organizational science research.

Just as BSPA partnered with the SBST to develop the federal policy series, we encourage other individuals, organizations, and agencies to propose topics that could be spotlighted with an article collection in *BSP*. As always, we welcome reader suggestions and look forward to interacting with many of you at our next annual conference (to be held in New York this September) and at Behavioral Science & Policy Association workshops.

Craig R. Fox & Sim B Sitkin
Founding Co-Editors


THIS NOTE IS LEGAL
FOR ALL DEBTS,

finding

The costs of poor health (plan choices) & prescriptions for reform

Saurabh Bhargava, George Loewenstein, & Shlomo Benartzi

abstract

Evidence suggests that when confronted with a large menu of health plan choices, consumers may not select the most efficient (that is, the most cost-effective) option. In anticipation of such problems, the exchanges set up by the Affordable Care Act (ACA) were designed to help consumers navigate the complexity of plan choices. Yet little is known about the actual efficiency with which ACA enrollees select plans. We present an analysis of projected health spending and a series of hypothetical plan choice experiments to explore the financial consequences of inefficient choices among potential ACA enrollees, the likelihood of such inefficient choices, and the potential for improving efficiency with a more behaviorally informed choice architecture. Our findings indicate that choosing a plan incommensurate with one's expected health care needs would lead to significant overspending relative to the most cost-effective plan and that, despite attempts to design the exchanges so that they facilitate decision-making, a significant share of ACA enrollees may have made inefficient decisions. More promisingly, we find that although the metal labels used in the exchanges to organize plans (for example, *Bronze* and *Silver*) encourage choices that are no more efficient than those associated with generic plan labels (such as *Plan A* and *Plan B*), labels that more sensibly reflect the factors consumers ought to consider—for instance, labels that emphasize gradations in the need for health care—do lead to significant improvements in the efficiency of plan choices.

Bhargava, S., Loewenstein, G., & Benartzi, S. (2017). The costs of poor health (plan choices) & prescriptions for reform. *Behavioral Science & Policy, 3*(1), 1–12.

Core Findings

What is the issue?
Choosing the correct health insurance policy remains a complicated task for many Americans. While the Affordable Care Act has dramatically expanded insurance coverage and created a standardized interface from which consumers can shop for plans, research suggests that it is likely that many consumers are not selecting financially efficient plans, and that the consequences of these mistakes are significant.

How can you act?
Selected recommendations include: 1) Replacing the metal labels of the ACA exchanges with labels that emphasize considerations crucial for efficient plan choice (e.g., anticipated medical use) 2) Offering customized plan recommendations or defaults informed by an individual's prior utilization

Who should take the lead?
Policymakers, consumer and policy advocates, health policy journalists

The Affordable Care Act (ACA)—otherwise known as Obamacare—has been the subject of debate from its inception to the furious recent attempts at its repeal. Although considerable attention has been devoted to the legislation's impact on expanding coverage and curbing health care costs, less has been paid to understanding whether the millions of new enrollees on the exchanges signed up for plans befitting their health needs. Indeed, many new enrollees likely had no experience choosing health plans from large menus of options, and the typical ACA enrollee in the first year chose from 47 plans differing in coverage, cost, and insurance provider.[1] Providing such a wide range of health plan features was the idea—according to economic theory, more choice should not only increase the likelihood that consumers enroll in a plan that meets their needs, but should also compel insurers to compete more intensively to lower costs and improve plan quality. However, if the dividends from greater choice and increased competition rely on consumers being able to accurately discriminate between plans, existing evidence on the insurance decisions that consumers make is cause for concern.

Insights From Prior Studies of Health Insurance Choices

Most existing research on the financial efficiency of consumers' health insurance choices falls into three categories: analyses of seniors enrolling in supplementary prescription drug plans through Medicare Part D, experiments involving hypothetical choices from stylized plan menus, and analyses of plan choices and health spending of employees choosing from employer-sponsored menus.

Several studies have documented examples of seniors overspending on prescription drug coverage obtained from the complicated exchanges for Medicare Part D, even after adjusting for factors such as health and tolerance for financial risk.[2–8] In one influential study, Jason Abaluck and Jonathan Gruber found that a majority of consumers made inefficient plan choices and that such inefficiency was due, at least in part, to consumers relying too heavily on plan premiums, rather than expectations of total out-of-pocket expenses, in their plan evaluations.[2] Another study found that simplifying plan choice by sending enrollees a letter with personalized information on plan costs—information that was already available at no cost to all consumers—led 28% of recipients to switch plans and reduce their health spending; 17% switched in a comparison group whose members did not receive the letter.[4]

A second set of studies demonstrated that the problem of inefficient choice extends beyond the elderly and Medicare by analyzing the hypothetical plan choices of experimental subjects.[9–11] The research showed that people frequently choose plans that are not optimal given their expected health needs and appetite for financial risk, even when incentivized to make efficient decisions. In one study, Eric J. Johnson and his colleagues presented experimental subjects with a scenario in which they were asked to choose a family health plan from a small menu of options after being provided with detailed information about the family's anticipated medical needs.[9] A majority selected financially suboptimal plans unless aided by health-cost calculators or vpersonalized default plans.

Skeptics might argue that working-age consumers making real-life decisions about their health care and finances would choose more efficiently than their elderly or experimental counterparts. At the very least, one would expect that such consumers would adjust their choices over time as they gained clarity about their need for health care and the costs of such care. A final set of studies examined these claims by analyzing the insurance decisions of employees who selected their plans from employer-sponsored menus.[12–15]

One such study examined the health plan choices of employees at a large U.S. firm, who selected plans from an unusually large and standardized menu.[12] (Hereinafter, we refer to this study as BLS, after the article's authors.) The firm afforded its employees an unusual degree of discretion by providing them a number of options for each of the four cost-sharing elements common to health insurance plans

"several of the plans were unambiguously more costly to consumers"

and then letting them choose any combination across these options.

This included four choices of deductibles (the amount the consumer must pay before plan coverage kicks in, excluding office visits), two for office copayments (the flat rate paid by a consumer for primary care and specialist visits), two for coinsurance rates (the share of costs, excluding those for office visits, covered by the plan after the deductible is met), and three for out-of-pocket spending limits (the maximum amount that a consumer might pay for the year, beyond the deductible). Other than these differences in cost sharing and each plan's premium, the 48 available plans (that is, 4 × 2 × 2 × 3) were identical—they were offered by the same insurer and covered the same network of doctors.

Beyond providing employees a large menu from which to choose, the firm provided an ideal setting from which to evaluate the quality of decisionmaking because of how the plans were priced. Several of the plans were unambiguously more costly to consumers than other plans, despite providing access to the same care. When two plans are equivalent in coverage and convenience but one guarantees higher total spending than the other, regardless of how much medical care the consumer seeks, the unfavorable plan is said to be *financially dominated*. Because of the way these plans were priced, nearly all of the 36 plans with deductibles lower than the highest available deductible of $1,000 would lead consumers to spend more than they would dole out for an otherwise identical plan with the high deductible. For example, employees had to pay $528 to reduce their deductible from $1,000 to $750—a maximum potential savings of just $250. A menu with a large share of dominated options provided the researchers with a rare litmus test that they could use to evaluate the ability of employees to choose cost-minimizing plans without the researchers having to know the employees' preferences for specific doctors, their medical needs, or their willingness to take on financial risk.

So how did the employees at this firm do? More than half of them wound up selecting financially dominated plans, spending more than they needed to by an amount equal to, on average, 24% of their annual premium. Lower income employees were especially likely to enroll in dominated plans, and employees who chose such plans in one year were unlikely to switch into alternative plans in the following year.[12]

Through a series of follow-up experiments, the authors investigated three possible explanations for this behavior. One was that employees who failed to select a cheaper plan did so because they were reluctant to search through a large plan menu due to the economic or psychological toll of the search. A second was that employees simply preferred plans with low deductibles, despite their considerable expense, because of distaste for the unpredictability and the inconvenience of out-of-pocket spending. The third was that employees were simply confused about how to compare the overall economic value of plans because they lacked understanding of how insurance programs worked. The experiments implicated this third explanation and suggested that the inefficient plan choices emerged largely from poor understanding of how to translate cost-sharing features, such as a deductible, into estimates of total health spending. Indeed, when subjects were presented with a simple menu consisting of four plans varying only in their deductible and price, and where three of the plans were dominated by the fourth, a majority of subjects chose the dominated plan. But when the financial trade-offs between plans were made explicit, subjects opted for one of the nondominated plans.

The Present Research: Plan Choice in the ACA

Because it was anticipated that consumers might have trouble navigating health plan choices, the ACA instituted a number of measures to help enrollees. These included a thoughtfully designed website, instructional

55%

share of employees choosing financially dominated plans at one large firm

24%

average overspending as share of plan premiums for those in dominated plans

11m

Americans enrolled in an ACA exchange plan as of March 2016

videos, online help, and a customer service phone line. The ACA also organized plans into cost-sharing tiers, tagged with metal labels: *bronze, silver, gold,* and *platinum*. On average, plans within each tier were required to cover, for a typical population, a predetermined share of health expenses, ranging from approximately 60% for the lowest tier (bronze) to 90% for the highest (platinum).

Our objective in the present research was to investigate whether these provisions of the ACA led to cost-efficient health insurance decisions by consumers, and to estimate the consequences of potentially inefficient decisions. To this end, in a first study, we estimated the financial consequences of inefficient plan choice for enrollees. Using data on prices and plan features for the thousands of plans from the initial year of the federal exchanges, we constructed a set of composite plans to represent each cost-sharing tier. We then estimated how much consumers of various ages and from various locations would spend under each of these composite plans, assuming a particular level of medical need. Finally, to understand the financial impact of the choices, we compared, for each type of consumer, the overspending associated with each composite plan choice relative to the plan that minimized expected health spending.

In a second study, we tested whether consumers were likely to choose efficiently when confronted with a health plan menu resembling those used in the ACA exchanges. Specifically, we presented survey respondents with a menu of composite health plans, constructed from those used in Study 1, featuring the metal labels used in the exchanges. To assess the efficiency of likely choices in the ACA exchanges and to identify alternative and potentially superior labeling strategies, we compared the pattern of plan selection from menus with metal labels with the pattern of plan selection from menus featuring less and then more informative plan labels.

Study 1: The Financial Consequences of Plan Choice in the Exchanges

Data Sources. We generated our sample from 78,522 plans listed on one of the 34 federal exchange platforms during the ACA's first year, after excluding data from catastrophic plans, plans for which we were unable to determine premiums, and plans from counties that failed to offer at least one plan in each of the four tiers of interest—bronze, silver, gold, and platinum. (See note A.) We then recorded plan prices and cost-sharing features for the remaining 39,885 plans across 220 insurance-rating areas—geographic regions within which insurance firms must price plans equivalently for consumers of similar age and smoking status—for four age categories (30, 40, 50, and 60 years). For simplicity, we restricted our estimates to couples with no children and did not attend to other differences across plans that might shape choice, such as insurer reputation or network configurations. Finally, to estimate projected health spending, we relied on age-specific utilization rates of employees reported in the BLS article.[12]

Research Design. To estimate the financial consequences of plan tier choice, we first constructed a set of composite plans to reflect the price and cost-sharing features of actual plans available within a plan tier for every age and region combination in our data (that is, 4 age categories × 220 insurance pricing regions). We generated these plans by calculating the unweighted average premium (assuming no tobacco surcharge), out-of-pocket maximum, and deductible for a married couple without children for every age and region combination for each cost-sharing tier. For analytic tractability, we assumed that each composite plan featured the modal copayment and coinsurance for all plans within that tier.

Having constructed a set of composite plan features corresponding to each tier for different types of consumers, we then projected the expected total health care spending for each of three categories of assumed medical need (low, middle, and high levels of care). For the low level of care, we assumed that the enrolled couple required no medical visits. For the medium level of care, we assumed that each enrollee required the same amount of care as the typical employee analyzed in the BLS article.[12] (See note B.) For this middle category, we further assumed a service cost of $200 for each primary care

visit and $350 for each specialist visit, in rough accordance with national averages. Finally, for the scenario involving a high level of medical care, we assumed each enrollee's medical costs exceeded the out-of-pocket maximum for each of the composite plans.

Next, we calculated the consequences of inefficient plan choice by identifying the plan associated with the least health spending for a typical enrollee of a given age, region, and level of medical need and calculating the excess spending of consumers choosing one of the alternative plans. Figure 1 reports these spending differentials for couples, averaged across age and region, relative to the cheapest composite plan for each level of medical need. The figure presents average overspending in dollars and as a percentage of the average premium of the most cost-effective plan.

Results. Our data indicate that a typical couple who required little medical care and opted for the plan from the tier associated with the second lowest total health spending would pay $1,662 (95% confidence interval [CI] range of $1,494 to $1,831) in excess of what they would have paid for the plan in the most financially advantageous (best) tier for them. The variation in these estimates is largely driven by pricing differences across age and region. If the couple had instead chosen the plan in the most expensive tier, their low level of actual medical service use would have resulted in their paying an excess of $4,706 (95% CI [$4,125, $5,291])—equivalent to 61% of the premium of the cost-efficient plan. For a couple requiring a high level of care, the plan in the most efficient of the four tiers would lead to excess spending equivalent to 59% of the annual premium of the plan in the least efficient tier. These estimates of potential overspending are highly stable across age groups.

An important feature of plan choice in the early years of the ACA was the premium tax credit available to enrollees with household incomes between 100% and 400% of the federal family poverty level. The presence of such refundable credits does not influence our estimates of overspending, because these subsidies can be applied to any plan. (See note C.)

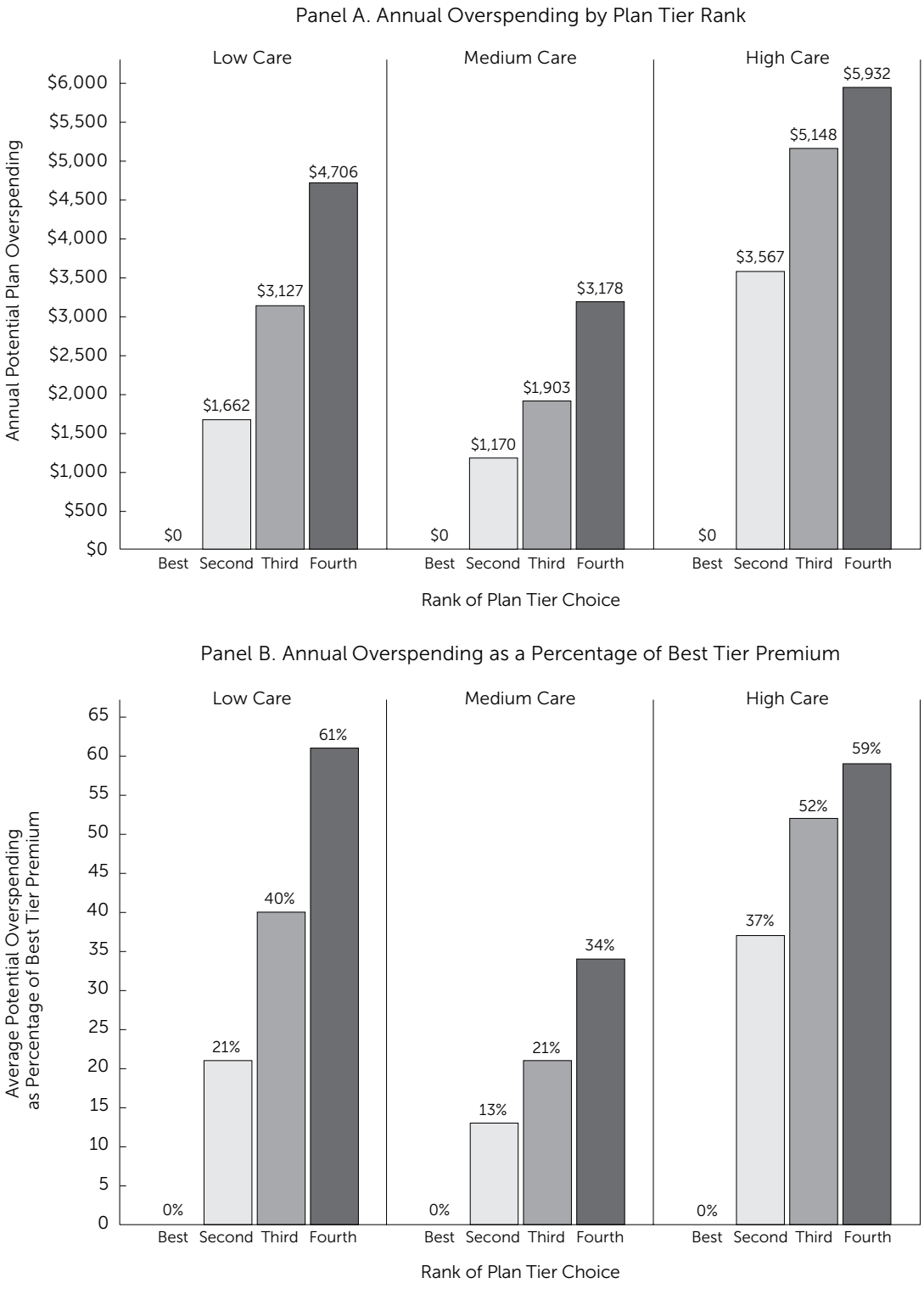
"the variation in these estimates is largely driven by pricing differences across age and region"

Study 2: Plan Choice in an Exchange-Like Environment

Given the severe financial consequences of choosing a plan not aligned with one's medical needs, our second study assessed whether the plan labels used by the ACA were likely to lead to efficient plan choices and, if not, whether such efficiency might be achieved by using menus with alternative labels. To investigate these issues, we ran an experiment in which subjects were asked to make choices from a hypothetical menu intended to resemble the design of the ACA exchanges. We graded the efficiency of plan choice by (a) assessing whether individuals chose the plan that minimized their expected health spending, based on projections of self-reported medical need, and (b) evaluating how choices varied when subjects were presented with menus with plan labels encouraging considerations of medical use.

Research Design. Our experimental subjects were 304 U.S. adults over the age of 25 years, recruited from the Qualtrics Survey Panel, a commercial survey panel commonly used by researchers. The subjects were given a survey lasting approximately 10 minutes. (See note D.) They were first asked about their demographic and financial background. Then we inquired about their health and how often they expected to seek care in the coming year. (See note E.) Finally, we directed subjects to choose a hypothetical insurance plan to cover themselves for the next year from a menu of composite plans constructed in the earlier study. For simplicity, we restricted menus to the three plans representing the bronze, silver, and platinum tiers; personalized plan prices only by age (rather than by age and geography); and included national averages of plan deductibles and out-of-pocket spending limits (which themselves were rounded

Figure 1. Potential health overspending for couples due to inefficient plan choices



This figure indicates the estimated overspending, averaged across age and region, associated with inefficient plan choice for childless couples given varying levels of presumed medical need. Panel A reports absolute differences in annual spending for each of the four available composite plans, ranked by their expected costliness relative to the cost-minimizing plan (that is, second, third, fourth). For example, for the typical couple requiring a high level of medical care, the choice of the second-cheapest composite plan would have led to $3,567 in additional spending relative to the cheapest available plan. Panel B reports overspending expressed as a share of average plan premiums. Please see the text for details on the construction of composite plans and estimates of health spending.

Table 1. Premium & cost-sharing features for composite plans (Study 2)

Composite plan by tier	Deductible	Monthly premium by enrollee age (in years)				Out-of-pocket spending limit	Office copayment or coinsurance rate (after deductible) by service		
		25 to 35	36 to 45	46 to 55	56 to 65		Physician	Specialist	Hospital
Bronze Plan	$5,094	$238	$267	$374	$567	$6,300	0%	0%	0%
Silver Plan	$2,911	$276	$311	$434	$659	$5,750	$30/visit	$50/visit	0%
Platinum Plan	$344	$345	$389	$543	$825	$2,000	$10/visit	$20/visit	0%

Note. This table displays the premium and cost-sharing features for the plans included in Study 2. Subjects were informed that all plans covered a set of essential benefits and included a modest copayment for prescription drugs, and that all hospital charges would be covered once their deductible had been met. The plans were designed to reflect typical features of the real-life plans from year 1 of the ACA exchanges. Please see the text for additional details on plan construction.

off). Subjects were told that all plans covered the same essential benefits (roughly corresponding to the basic services covered in the ACA), had a modest copayment for prescription drugs, and would cover all hospital charges after the deductible had been met. Table 1 describes the premiums and cost-sharing features of the composite plans.

Plan choice proceeded in three steps, which, for the baseline (metal labels) condition, we depict in Figure 2. After the choice paradigm was introduced (see Panel A), subjects were given the option of filtering plans by tier or viewing all plans (see Panel B). Upon making this decision, subjects were shown the prices and cost-sharing features associated with selected plan(s) (see Panel C) and were given the chance to see all available plans again. Subjects were randomized into one of four experimental situations, each associated with a different set of plan labels:

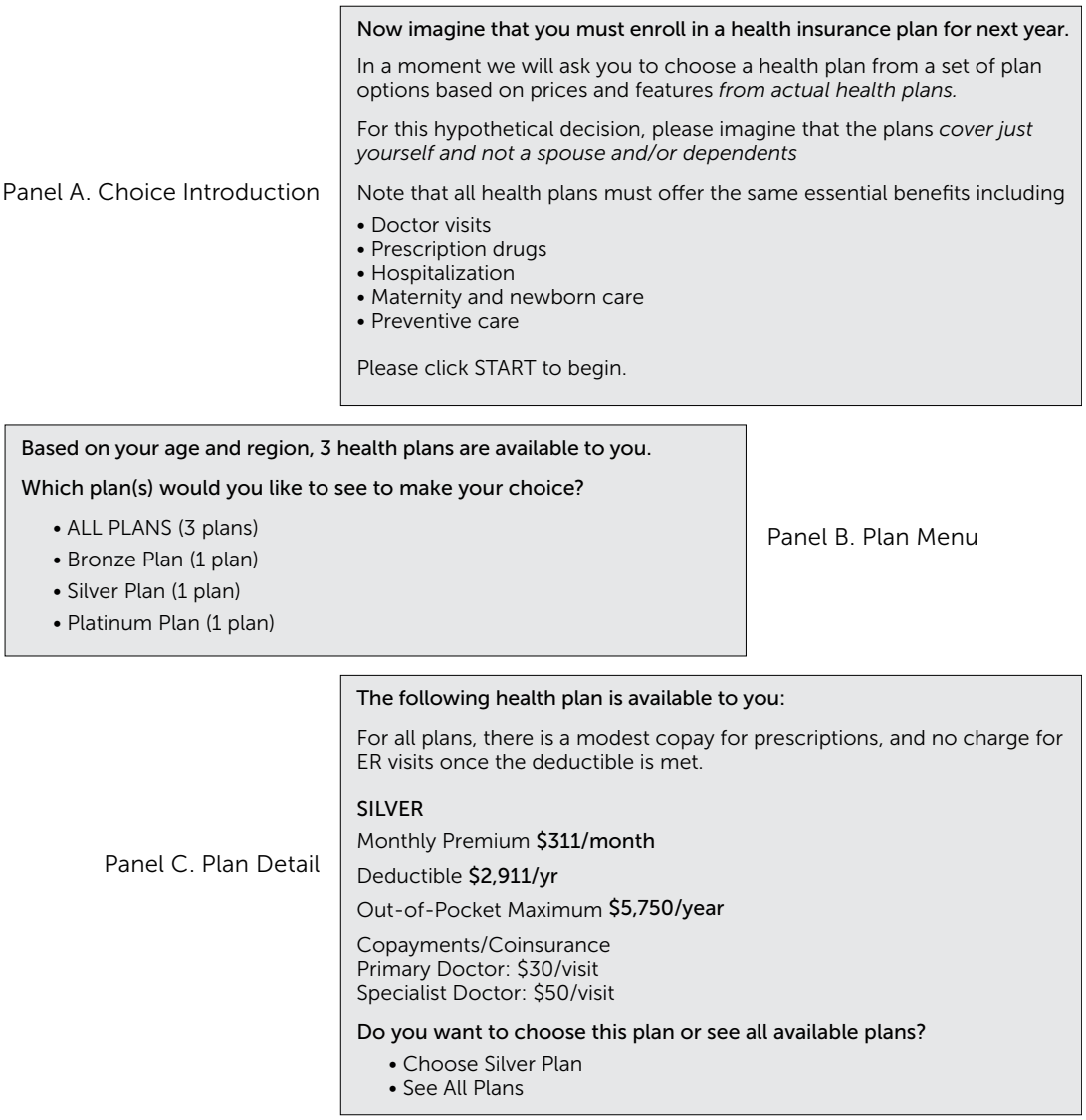
- Metal labels (*Bronze, Silver,* and *Platinum*)
- Generic plan labels (*Plan A, Plan B,* and *Plan C*)
- Medical use labels (*High-Use, Medium-Use,* and *Low-Use*)
- Generic plan labels accompanied by a plan recommendation

We assessed the efficiency of plan choice in two ways. First, we documented whether the plan selected by a subject minimized the subject's expected health spending, a value based on the two measures of anticipated utilization collected from the survey. To calculate a subject's expected health spending for each plan choice, we assumed the same per-visit costs as in the first study and additionally assumed a service cost of $2,000 for each hospital visit, in rough accordance with national averages. Second, to evaluate efficiency of choice from menus featuring the exchange-like metal labels, we compared such choices with the choices made by similar subjects from menus with more informative labels. (See the BLS article for a detailed discussion of a criterion for evaluating choice efficiency.)[12]

Results. Figure 3 depicts the likelihood that subjects minimize their expected health spending under different labeling regimes. As shown in Panel A, only 33% of respondents chose the cost-minimizing plan from menus with metal labels similar to those used in the ACA exchanges. Forty-three percent chose plans providing coverage exceeding anticipated need (we designate this group *the overinsured*), whereas 24% chose plans providing too little coverage (*the underinsured*). Panel B shows that those selecting plans from the menus with metal labels overspent by an average of $888 (95% CI [$681, $1,095]), or 16% of the typical premium across all subjects.

The figure also depicts the comparative efficiency of choices when alternative labeling schemes are used. Average overspending for subjects choosing from a menu with generic labels was $794 (lower but not significantly distinguishable from the overspending seen with the metal labels, p = .52). Subjects choosing from menus with labels emphasizing consideration

Figure 2. Experimental interface for the metal label condition in Study 2

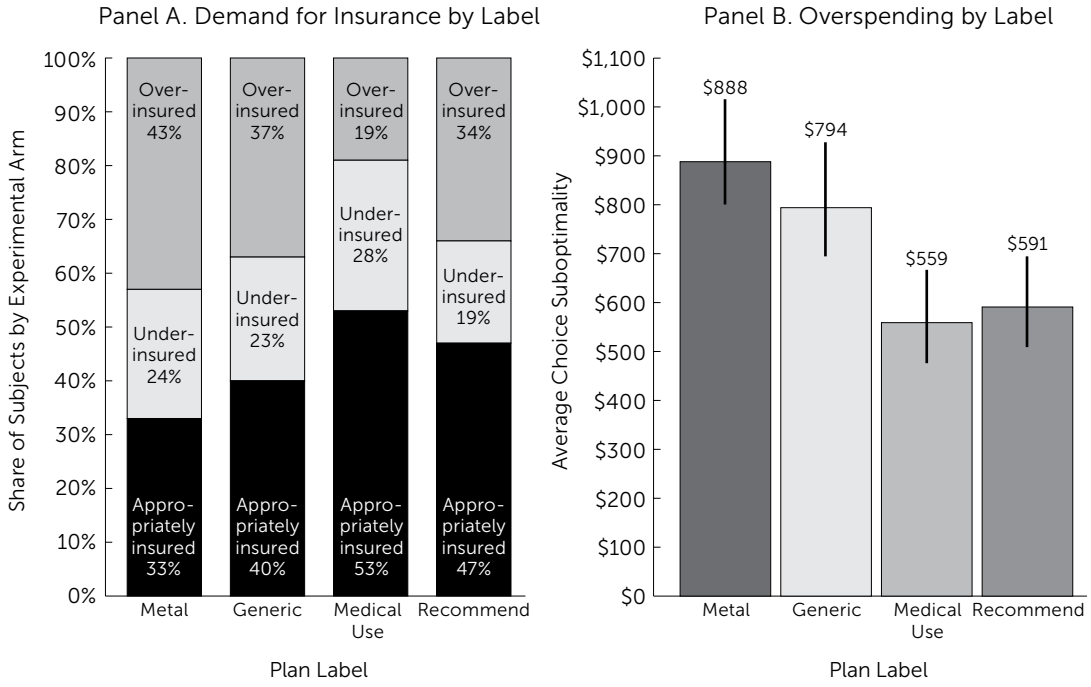


of medical use overspent by an average of $559 (95% CI [$378, $740]), and subjects choosing from menus with generic labels and personalized recommendations overspent by an average of $591 (95% CI [$401, $781]). In the latter two choice environments, subjects chose plans that were significantly more cost-effective than the ones subjects chose under the labeling regime currently used by the ACA exchanges ($p < .05$). When we calculated the magnitude of overspending only for those respondents who chose inefficiently, the metal labels led to $1,324 (95% CI [$1,080, $1,568]) in average excess spending, or 24% of the typical premium.

Discussion & Implications for Policy

Our studies suggest that for consumers purchasing plans through the exchanges of the ACA, the economic consequences of enrolling in a plan that provides either too much or too little coverage is significant. The first study indicates that an individual's choice of the second-best plan tier, as measured by cost efficiency, would cause the person to overspend an equivalent of 13% to 37% of plan premiums (see Figure 1, Panel B). If consumers were to choose plans at a rate no better than chance,

Figure 3. Demand for insurance & health overspending across choice architecture



This figure reports the results of an experiment in which 304 subjects were asked to make a hypothetical insurance decision from a plan menu whose appearance varied across experimental conditions. Panel A reports the share of subjects within each labeling condition who selected a plan that led them to become over-, under-, or appropriately insured based on their self-reported expectations for medical spending. Panel B reports the average overspending, relative to that subject's cost-minimizing plan, for each labeling condition. Error bars indicate an interval of ± 1 standard error.

as suggested in other studies,[12] inefficient plan choice could be even more costly. Choosing the least cost-effective plan tier leads to average overspending amounting to 34% to 61% of plan premiums, depending on one's expected level of medical need. Although our analysis relies on several simplifying assumptions, the findings, in conjunction with the prior research discussed above, point to the large financial stakes of poor health insurance decisions.

The second study indicates that consumers participating in the ACA are not likely to make efficient plan choices. The two-thirds of subjects in the second study who chose a plan incommensurate with their medical needs from menus that rely on the same metal labels used in the ACA exchanges (and that feature plans with no differences in networks or provider) overspent by $1,324, equivalent to 24% of the average plan premium. Although the subjects in the second study made only hypothetical decisions, there is reason to believe that the findings from such experimental paradigms are fairly generalizable. In their examination of thousands of actual decisions of employees and hypothetical decisions of experimental subjects, Bhargava, Loewenstein, and Sydnor reported a striking similarity in the distribution of plan choices.[12] Moreover, experimental studies have found that the presence of financial incentives does not lead to a significant difference in the efficiency of plan choices from hypothetical menus.[9]

It is possible that, on the one hand, the observed demand for excess coverage might reflect an informed preference to avoid financial risk. On the other hand, the observed demand for too little coverage might reflect the high costs of raising funds to pay premiums when individuals have little available cash on hand. We have several reasons to think neither explanation fully accounts for the patterns we observe.

First, one mark of whether plan choices reflect a coherent and informed set of preferences is the

"insurers might not be driven to eliminate the complicated, profit-generating features of health insurance products"

consistency of such choices across menus that vary in the transparency of their presentation. We find that subjects are significantly more likely to minimize spending under more informative labels, suggesting that the behavior of subjects choosing from menus with metal labels does not reflect fully informed decisions. Second, to understand if plan choices can be explained by a preference for avoiding financial risk-taking, we asked respondents about their general willingness to take on financial risks (on a scale of 1 to 10). Although we caution that these estimates are not highly precise, after controlling for self-reported health and income, our elicited measure of financial risk-taking did not predict demand for overinsurance ($b = -.02$, $p = .33$) or underinsurance ($b = -.005$, $p = .81$). (See note F.) Finally, the research discussed above implies that the behavior of subjects in our studies more likely reflects deficits in health insurance literacy than informed preferences for avoiding risk, budgeting convenience, or illiquidity.

We can estimate the approximate implications of our findings for consumer welfare under the ACA. If two-thirds of the roughly 8 million people who enrolled in the ACA in the inaugural year of the exchanges chose plans that led to average overspending amounting to $1,324, the result would be roughly $7.1 billion of excess spending each year, borne by a population with low to moderate incomes. The consequences of consumers making suboptimal decisions extend beyond those consumers feel directly. Some economists have argued that in markets with a significant share of consumers who are not fully informed, insurers may be subject to less competitive pressure to reduce prices and improve quality—and may even compete by confusing consumers and then persuading them to purchase lucrative suboptimal plans.[16–19] Thus, insurers might not be driven to eliminate the complicated, profit-generating features of health insurance products. Consistent with this general thesis, other work offers evidence that the growing complexity of certain financial products correlates with higher profits for banks and reduced consumer welfare.[20]

Why are consumers prone to making suboptimal plan choices despite labeling designed to facilitate optimal decisions? Astute choice of a cost-sharing tier in the exchanges requires careful consideration of one's expected medical expenses. Those anticipating a modest need for medical care should spend less, on average, by selecting a plan in a low cost-sharing tier, while those anticipating substantial care should benefit, on average, by choosing a plan with greater cost sharing. An explanation consistent with our findings is that people might fail to interpret the metal labels as signaling a gradation in the degree of cost sharing associated with each tier. Instead, they may interpret the labels as implying differences in the quality of medical care or access to such care. This explanation is supported by the second study, in which labels designed to encourage consumers to choose plans based on expected use led to demand for less expensive plans. The possibility that consumers rely on metal labels as a global measure of quality is also suggested by a recent survey that found that, among respondents deemed to be below the median in mathematical ability, gold plans were preferred to other plans regardless of the underlying plan features.[21]

Collectively, our evidence and the research on which it builds suggest that the psychology governing the implementation and marketing of health policy may deserve as much attention as the policy's underlying economic structure. Practically, the second study suggests that the adoption of labels that imply gradations in expected medical use—a more logical dimension for plan comparison than that implied by metal labels—could improve the efficiency of enrollee choices for health insurance plans. Although the feasibility of moving away from the metal labels is unclear in the present regulatory

environment—such a move would likely require legislative action—behavioral science offers several alternative strategies to encourage more efficient choices. These strategies include the use of plan recommendations; personalized health-cost calculators; education through real-time, scenario-based examples; or the simplified presentation of the trade-offs most relevant for plan comparison.[9,22] To the credit of policymakers, the online architecture of the ACA exchanges has evolved since its inaugural year. In various incarnations, it has featured decision tools, such as health-cost calculators, and displays emphasizing the projected total spending associated with each plan.

Although such innovations are commendable, it is unclear whether decision tools and cost projections situated amid an array of other plan information will lead to improvements in consumer decisions. Ultimately, policymakers should reconsider the benefits of restricted health plan menus or personalized defaults that do not lead consumers into costly and persistent errors in enrollment. More ambitiously, policymakers might consider fundamentally simplifying the structure of insurance so that consumers better understand the plan choices provided to them.[23,24]

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endnotes

A. Data were from the Qualified Health Plan landscape, accessed in July 2014 from http://www.healthcare.gov.

B. Specifically, we assumed that the average number of visits per enrollee is 5.7 for primary care physicians and 5.8 for specialists among 30-year-olds; 5.9 and 7.5, respectively, for 40-year-olds; 6.3 and 9.5 for 50-year-olds; and 7.1 and 11.7 for 60-year-olds. We doubled these figures to arrive at the numbers for couples.

C. For a smaller subset of individuals eligible for additional cost-sharing subsidies, potential overspending may differ from the reported figures.

D. The subjects were diverse in gender (men = 38%, women = 62%), age (26 to 35 years = 18%, 36 to 45 = 23%, 46 to 55 = 25%, older than 55 = 33%), yearly income (up to $30,000 = 34%, $30,001 to $50,000 = 24%, $50,001 to $80,000 = 25%, $80,001 to $120,000 = 10%, greater than $120,000 = 7%) and education (college = 40%, some college = 39%, high school = 19%, less than high school = 2%).

E. Our primary measure of expected utilization involved asking subjects how many times they expected to see a doctor or visit a hospital in the next year. As a second, more qualitative measure, we asked subjects if they expected to seek little or no care, a moderate amount of care, or a great deal of care.

F. We separately modeled demand for over- and underinsurance as defined in Figure 3 with a linear probability model in which demand is a function of a participant's self-reported risk, after controlling flexibly for self-reported health and income. We note that these estimates are fairly imprecise given the small experimental sample in each labeling condition.

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review

Improving voting systems' user-friendliness, reliability, & security

Michael D. Byrne

abstract

About half of Americans have limited confidence that their vote will be properly counted. These fears have focused attention on voting system reliability, security, and usability. Over the last decade, substantial research on voting systems has demonstrated that many systems are less usable and secure than they should be. Producing truly reliable voting systems demands more than just following the federal guidelines enacted in 2005 (which, although well intentioned, have failed to substantially improve current systems) or simply updating voting systems to electronic voting computers using monies allocated by the 2002 Help America Vote Act (HAVA). In fact, HAVA has inadvertently led to the purchase of systems that may have actually increased the vote error rate. Key reforms needed to deliver reliable voting systems include substantial testing for usability, especially regarding the accurate capture of voter intent and the reduction of voter error rates, and measures to ensure the integrity of elections, such as election officials' ability to secure ballots.

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Core Findings

What is the issue?
After the Help America Vote Act passed in 2002, many states transitioned to direct recording electronic voting machines. While these improved usability for disabled voters, they did not improve error rates over traditional voting methods. Further usability and security testing is needed to improve the integrity of U.S. elections.

How can you act?
Selected interventions include:
1) Joining electoral machine research and design efforts in Travis County (Texas) and LA County (California), and across other jurisdictions, to pool resources
2) Embedding behavioral science research and insights in electoral design processes

Who should take the lead?
Behavioral science researchers, security experts, election officials

Throughout the 2016 presidential election season, dark claims were floated about the election being rigged, and almost half of all Americans have limited confidence that their vote will be properly counted, according to an October 2016 survey.[1] These fears focus attention on the voting procedures and systems used in the United States. Are they, in fact, fair, and do they give all citizens a voice, as the Constitution requires? And in the wake of the vote recount efforts by Green Party candidate Jill Stein and the Clinton campaign, with both camps voicing concerns of potential computer hacking,[2] Americans may yet wonder: are their votes secure?

The voting process has been questioned before, particularly following the contested presidential election of 2000 and the infamous butterfly ballot (see the sidebar *The Butterfly Ballot From Palm Beach County, Florida, 2000*). Two years later, with strong bipartisan support, Congress passed legislation called the Help America Vote Act (HAVA) of 2002 to address election administration problems.

HAVA allocated billions of dollars to local jurisdictions to replace outdated voting equipment. But it turned out that many of the voting machines those jurisdictions rushed to purchase, most often voting computers known as *direct recording electronic* machines (DREs), offered little to no improvement. In fact, HAVA likely made usability worse for some voters in terms of preventing voter errors, because some of these replacement systems were measurably worse than traditional paper ballots, the best alternative then available.[3]

The fundamental problem with HAVA is that it put the need for purchases ahead of the science. The law imposed substantial pressure on county clerks to purchase new voting systems and granted them generous budgets to do so, yet it offered almost no scientific evidence to guide them on which systems were most usable and most secure. Commercial vendors, hungry for an allotment of the billions about to be spent, rushed in with poorly designed systems. These early systems were primarily DREs. They were not only scientifically unproven to enhance voting usability but also failed to follow industry best practices for both usability and computer security that had been established in the decades prior.[4]

However, there were positive consequences as well. The contested 2000 election spurred a wave of new research on many aspects of voting, including voting system usability, election administration practices and procedures, computer security, and statistical auditing methods.

For example, the Caltech/MIT Voting Technology Project (http://vote.caltech.edu/), an interdisciplinary research effort focused primarily on political science, has produced a substantial amount of valuable research on voting, particularly on election administration. For example, the idea of a residual vote—the difference between the total number of ballots received and the total number of votes cast in a particular race—came from this research and has now become a standard measure of the quality of voting systems.

The ACCURATE Center (http://www.accurate-voting.org/), a 6-year interdisciplinary research center funded by the National Science Foundation, focused instead on both computer security and voting system usability. The center is responsible for the vast majority of the research on voting system usability published since the center's inception in 2005. In addition, the center's research has yielded ideas that will likely be incorporated into the security and cryptography architectures of future voting systems.

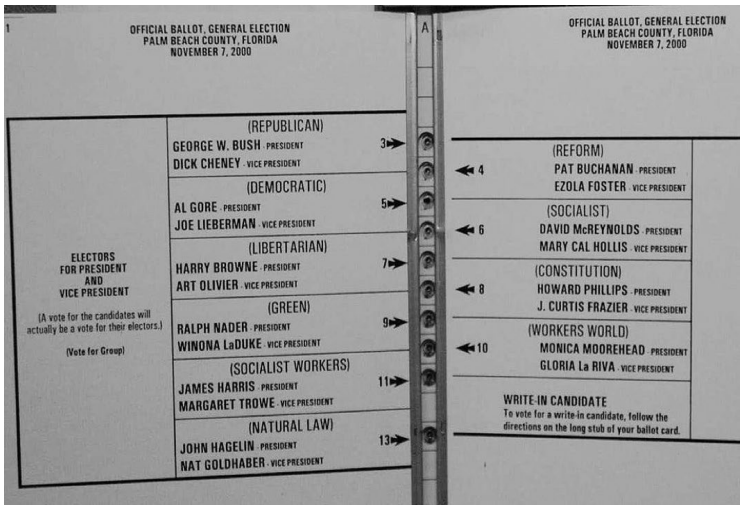
In this article, I focus on usability, but usability is not by any means the only important consideration. A truly successful voting system must address multiple factors, such as security, usability, accessibility, certification, ease of administration, cost, compliance with election laws, transparency, and auditability. Clearly, improving and updating the country's voting methods, practices, and administration is no simple task.

Human Factors of Voting Systems

Human factors is an academic discipline concerned with matching engineered systems to human capabilities. A human factors researcher,

The Butterfly Ballot From Palm Beach County, Florida, 2000

This confusing ballot played a key role in the 2000 U.S. presidential race. Many voters inadvertently chose Buchanan/Foster when intending to vote for Gore/Lieberman, and even more voters failed to cast a valid vote in the presidential race. A follow-up behavioral study using a paper ballot and Canadian participants (who were unaware of the Palm Beach ballot) showed that they made similar errors on 8% of the ballots and rated the butterfly ballot more confusing than a single-column ballot.[A]



A. Sinclair, R. C., Mark, M. M., Moore, S. E., Lavis, C. A., & Soldat, A. S. (2000, December 7). An electoral butterfly effect. *Nature, 408,* 665–666.

for example, might investigate how to design a website so its visitors can quickly and easily find what they are looking for. Most human factors academic programs are housed in psychology departments, although some are in industrial engineering programs or schools of information. Human factors started as a field of study in the 1950s, primarily in aviation, where practitioners investigated how to reduce deaths by designing cockpits and training pilots to match their capabilities with what the engineers who built the airplanes assumed they were.

Usability and human error are human factors problems. A 2004 report issued by the National Institutes for Standards and Technology (under the direction of the Federal Election Assistance Commission) acknowledged that there was a dearth of research data on voting system usability, noting that virtually no significant human factors studies of voting systems existed.[5]

An international standard for usability measurement provides a three-component definition for usability: effectiveness (the accuracy or completeness users achieve with specific goals in the target environment), efficiency (the resources expended by users in relation to the effect achieved), and satisfaction (a subjective rating of the system).[6] Table 1 applies these universal usability definitions specifically to the voting context.

Laboratory Studies on Legacy Voting Systems

In the mid-2000s, my colleagues and I did some of the first systematic studies designed to assess the usability of legacy voting technologies.[7,8] (For these studies and other research done by me and my colleagues, voting-age adults were recruited from the Houston, Texas, area through a mix of newspaper and Internet advertising. These samples were generally close to balanced on gender. They represented age ranges from roughly 20 to 80 years and contained people representative of a broad mix of other demographic variables, such as education and ethnicity. For details, consult the individual cited papers.)

First, we assessed voter error in each of three traditional voting systems: paper ballots, punch cards, and lever machines. Voter error occurs when a voter casts a vote for someone other than

Table 1. Usability of voting systems

Component	Definition	Note
Effectiveness	Voter error rate	Requires knowing the voter's actual intent. Therefore, for privacy reasons, the voter error rate cannot be studied in real elections; it can only be studied in the laboratory, where the voter's intent can be known.
Efficiency	Time needed to fill out and cast a ballot	
Satisfaction	Subjective user satisfaction	Generally measured by a subjective usability questionnaire such as the System Usability Scale (SUS).

"the voting technology used had no effect on how quickly voters cast their ballots"

the person whom the voter intended. Voter error also occurs when a voter fails to cast a vote when she or he intended to. These errors are impossible to assess in real elections because ballots are secret. In the laboratory, however, we were able to assemble diverse groups of voting-age adults and assign them to participate in a mock vote with each of the three voting systems.

We determined voter intent using one of two methods. We gave mock vote participants either (a) a list of candidates to vote for and measured errors as deviations from that list or (b) a booklet with names and descriptions of fictional candidates and then asked them to cast their ballots in all three systems but vote the same way on each ballot. When a voter cast a vote that did not match his or her other ballots, we counted that ballot as having an error.

We determined voter error rate, the measure of a voting system's effectiveness, by comparing each voter's intent with the actual vote that person cast. We measured a voting system's efficiency by tracking the time it took each person to cast a ballot. We also measured voter's satisfaction with a system using the System Usability Scale (SUS), a standard usability questionnaire.[9]

The key findings were straightforward: The voting technology used had no effect on how quickly voters cast their ballots, but it did affect their error rate and user satisfaction. Error rates with paper ballots averaged 1%–2%, which was markedly lower than the error rates produced by punch cards and lever machines (typically around 3%–4%, but sometimes even higher than that). Voters also indicated via the SUS questionnaire that they were somewhat more satisfied when voting with paper ballots than with punch cards and lever machines.

We also discovered that when voters have a list in hand of whom to vote for, they make fewer errors, regardless of the technology used. This is most likely because it is easier to work directly from a list and not from memory—an important distinction, because many voters do not bring lists into the voting booth. In fact, in some jurisdictions, it is illegal to do so.

Electronic (DRE) Voting Problems

As we were conducting our studies on the usability of legacy voting system, other research teams were investigating the new commercial DREs that flooded the market after HAVA become law.

A research team led by Paul Herrnson, a professor of political science now at the University of Connecticut, conducted a large study comparing the most popular commercial DREs available on the market.[3] They measured voter error by giving mock vote participants a list of candidates and measuring how often their actual votes diverged. They found that even the best commercial DREs were no better than paper ballots and most were worse, some substantially so.

HAVA mandated that voters with special needs be given an accessible way to vote. Commercial DREs are more accessible than paper ballots, punch cards, and lever machines, all of which are essentially impossible to use by voters with various disabilities, such as blindness or substantial motor impairments. The accessibility features (mostly audio-based presentation of the ballot) of these early DREs were quite poor by modern standards,[10] but they did allow jurisdictions to comply with HAVA's accessibility mandates. After HAVA, some jurisdictions combined paper ballots and DREs, whereas others moved entirely to DREs. These changes carried other costs. County clerks essentially had to become information technology managers, a new role for them. Furthermore, in some cases these changes likely led to more voter errors if paper ballots were replaced with DREs. Therefore, although DREs may make the physical act of casting a vote easier for people with certain disabilities, they are not necessarily better for the general voting population, at least compared with paper ballots.

In other words, voting systems became measurably less usable in jurisdictions that moved from paper voting to early DREs after HAVA became law in 2002. Jurisdictions that moved from punch cards or lever machines to DREs generally did not take as big a step backward, but overall, the change was not always progress.

"County clerks essentially had to become information technology managers"

Problems With Early DREs

To improve commercial DREs, it is first necessary to figure out what makes most of them so difficult to use. Some fail to conform to simple guidelines about text size and readability. Some require voters to follow novel and unusual procedures. Others have poor touchscreens, confusing instructions, or other complications. Almost every DRE on the market in 2008, when Herrnson's team conducted their study, has not one but multiple usability problems.

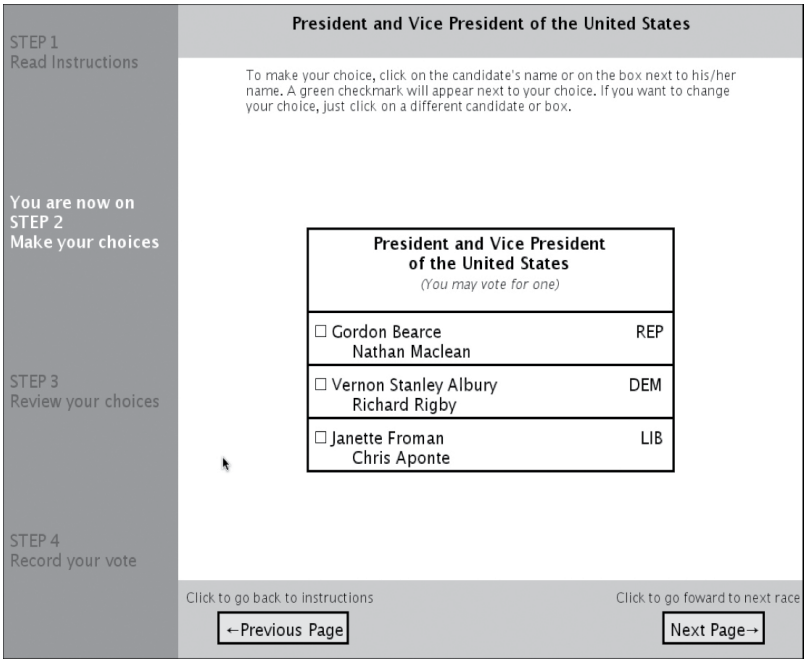
To understand why DREs are difficult to use, my colleagues and I constructed a DRE for research purposes. Like all other DREs, this one, called VoteBox, is a computer system. Unlike most other DREs, VoteBox is not a touchscreen; voters interact with it while either sitting or standing by clicking on buttons using a standard computer mouse. (See one of the VoteBox screens in Figure 1.)

VoteBox was intended to be a better DRE than many early commercial DREs, which did not conform to federal usability guidelines issued in 2005.[11] These guidelines, The Voluntary Voting System Guidelines, called for voting systems to meet basic criteria for usability and security. They also identified a minimum text size, a minimum contrast, and other features to help make the systems more usable.

The VoteBox DRE met these minimum standards, but it went no further. How did the VoteBox DRE compare with traditional systems? To examine the causes of differences in voting behaviors, we conducted a laboratory study in which we randomly assigned mock vote participants to vote on a medium-length ballot (27 races) twice: once using the VoteBox DRE and once using a traditional system (either a bubble-style paper ballot, a lever machine, or a punch card).[12] We also randomly assigned half of each group to vote from a list of preferred candidates, whereas the other half chose from a booklet with the names and descriptions of fictional candidates. We instructed those in the booklet group to choose candidates and vote the same way on multiple ballots. And to control for the order of voting (DRE vs. other system), we had half the voters vote first with the DRE and half vote first with the traditional system.

As it turned out, our in-house DRE was no more effective or efficient than the traditional systems. It took at least as long to vote on the DRE as it did on other technologies. (More educated voters vote slightly faster overall, regardless of technology—a result often seen in such studies, and here we found the same.)

Figure 1. Screenshot from the VoteBox research direct recording electronic voting system



The VoteBox DRE did not reduce the error rate compared with paper ballots. In fact, when we compared VoteBox or one of its variants with paper ballots in our subsequent studies, the two had a similar error rate of roughly 1.5%. The results demonstrate that simply following basic usability guidelines can help improve usability, but that alone is not enough to do better than the best legacy technology, paper.

Advantages of DREs

Paper ballots, although not very accessible, produce a record that is readable by humans, less vulnerable to malicious electronic tampering, and auditable later. Yet despite their drawbacks, DREs have some advantages over paper ballots. Even when voters make errors, interpreting the submitted ballot in a DRE is unambiguous, whereas interpreting a paper ballot is not. Consider the 2008 Senate election in Minnesota. A razor-thin margin of victory caused statewide recounts, and the two major political parties spent months contesting ambiguous paper ballots, such as the ones shown in Figure 2. (An excellent resource full of examples from this election can be found at http://minnesota.publicradio.org/features/2008/11/19_challenged_ballots/round1/.) Although DREs might not improve voter error rates, they also do not lead to such complications.

The one way that VoteBox differed consistently from legacy systems in our experiments was in satisfaction: Voters repeatedly rated VoteBox as more satisfying to use than traditional systems. For example, using the SUS—the same standard usability questionnaire my colleagues and I used in all of our studies—our voting experiment participants rated VoteBox as substantially more satisfying to use than bubble-type paper ballots, lever machines, and punch cards. The satisfaction scores are, in fact, unusually high for engineered systems of any kind, and the results held for young and old voters, computer experts and computer novices, rich or poor, and similarly wide ranges on other demographic variables.

More critically, those who used VoteBox were more satisfied than were those who used traditional systems, regardless of which system allowed them to vote faster or make fewer errors (see Figure 3). This has two implications. First, just because voters like a system does not mean it generates lower error rates or allows people to vote in less time. Second, election officials who move away from DREs may find that their voters dislike the change.

Figure 2. Ballots from the 2008 Minnesota Senate race

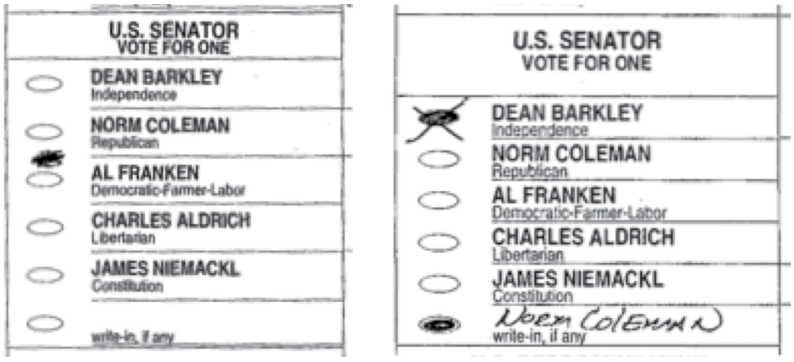
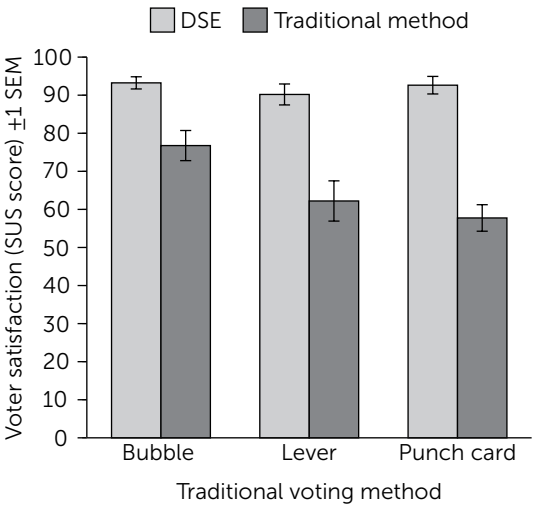


Figure 3. Voter satisfaction by voting system



Voters report being significantly more satisfied with the voting process when using direct recording electronic (DRE) voting machines than when using the following traditional methods: paper bubble ballots, lever machines, or punch cards. Voter satisfaction was measured by a standard survey called the System Usability Scale, which runs on a scale from 0 to 100, and the values shown are the mean across the voters. The error bars show the standard error of the mean—a statistical measure of how widely the results varied from voter to voter. Data come from "Electronic Voting Machines Versus Traditional Methods: Improved Preference, Similar Performance," by S. P. Everett, K. K. Greene, M. D. Byrne, D. S. Wallach, K. Derr, D. Sandler, and T. Torous, 2008, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: CHI 2008,* New York, NY: Association for Computing Machinery.

Ensuring DRE Security & Accuracy

Some voters have stated that they like voting on DREs because after they have navigated through the ballot, they can review those choices on the last screen before submitting their vote. **If the voting machine software was malfunctioning—or, worse, maliciously altered—would voters notice the altered votes on the review screen?** We have done multiple studies showing that most of the time, voters do not. In fact, **roughly two-thirds of voters failed to notice changes, even though the study used a permissive standard for what counted as noticing the change.**[13] When voters were asked if they noticed anything amiss on the review screen, they got credit for detection if they said that something was wrong, even if they could not articulate what it was. What this suggests is that security measures that depend on voters thoroughly checking their ballots are unlikely to be completely effective.

One of the earliest proposals for improving the security of DREs was to have the machines also print out a paper record that voters could examine through glass.[14] These records are generally produced by inexpensive thermal printers—imagine a low-quality, light purple credit card receipt. If voters do not notice anomalies on the high-resolution display immediately prior to casting their vote, it seems highly unlikely that they would notice them under even worse visual conditions. This suggests that other security measures are necessary.

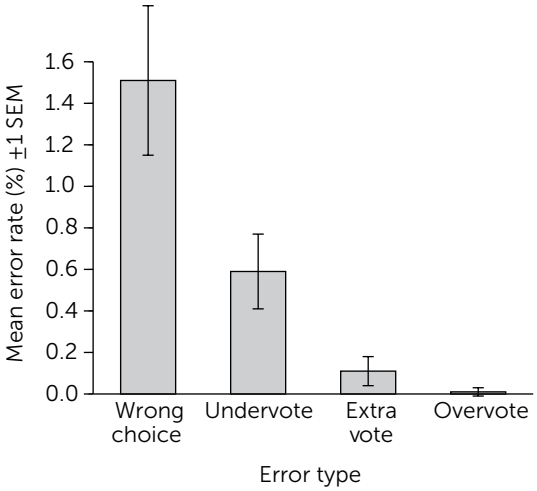
We tested two other interface manipulations in our experiments and found that there was little difference in error detection rates based on where the votes were on the ballot or the number of votes that were altered.[15] Changing the interface to highlight party affiliation and missing votes helped a bit, but even in the best case, this brought detection rates up to just 50%.

Instead of relying on voters to detect their own errors, sometimes errors can be detected using the residual vote rate.[16] Residual votes occur when voters fail to cast a vote or when they invalidate their vote, for example, by selecting two candidates in a contest where only one is allowed. When the residual vote rate is unusually high, this can alert election officials that something went wrong.

However, some residual votes do not indicate voter error. When a voter abstains on purpose—perhaps because he or she doesn't like any of the candidates—this also counts toward the residual vote rate. Say Mary is an avid voter but chooses not to vote in races in which she doesn't like any of the candidates or on propositions that she feels uninformed about. Mary's intentional abstentions would be counted toward the residual vote rate, despite not actually being errors.

There are also errors that do not show up in the residual vote rate—for example, if a voter meant to choose one candidate and instead selected another. Unfortunately, my colleagues and I have demonstrated that wrong-choice errors are much more common than other error types (for example, see Figure 4). This means that the residual vote rate is not necessarily a good indicator of a bad ballot. It also suggests that voting system designers cannot rely on the

Figure 4. Frequency of different voting error types



Overvote indicates that the voter selected too many candidates. *Omissions* indicate that a voter who intended to vote instead made no choice. *Extra vote* means a voter who intended to abstain accidentally selected a choice. The error bars refer to the standard error of the mean. Data are from "Now Do Voters Notice Review Screen Anomalies? A Look at Voting System Usability," by B. A. Campbell and M. D. Byrne, *Proceedings of the 2009 USENIX/ACCURATE Electronic Voting Technology Workshop/Workshop on Trustworthy Elections,* https://www.usenix.org/legacy/events/evtwote09/tech/full_papers/campbell.pdf.

1-2%
voting error rates for paper ballots

55%
of Americans have only some, or little confidence that their vote will be properly counted

3-4%
voting error rates for punch cards and lever machines

"it is unlikely that a one-size-fits-all approach will be effective"

residual vote rate to indicate the true error rate and instead need to conduct laboratory usability studies that can verify voter intent. High residual vote rates can indeed indicate problems, but low residual vote rates do not necessarily mean that ballots were cast accurately.

Building Usable Voting Systems

Although there is still a great deal that is not known about voting system usability, the last decade has produced some key lessons:

- The most critical measure of a voting system's usability is the system's ability to accurately capture voter intent. The time it takes to cast a ballot is also important, but it is not particularly sensitive to design. Acceptable satisfaction with a voting system is relatively easy to achieve.

- Almost all changes in the way people vote impact usability, from ballot layout to small choices in wording on instructions. So although guidelines are a good start and can help prevent certain classes of usability problems, they are insufficient to guarantee usable voting systems. Usability testing, both during the design process (usually multiple times) and after the design is finalized, is critical.

- DREs offer the best avenue to accessibility for those with a disability, but most DREs in use today produce untenably high error rates. Yet with careful usability testing, they can most likely be made more effective than legacy systems (even paper). Usability testing at multiple stages of development is a key requirement, one that no current commercially available system has met.

- Both security and usability must be considered early in the design of the system, and it is important to take great care not to compromise one for the other. This can be a difficult balance, but it is critical.

- Voting by mail is not an ideal solution. The vast majority of U.S. voters still vote in person at their designated polling place, but in some areas of the United States (predominantly on the West Coast), voting by mail has become popular. However, this approach is not favored by most voting security researchers because it offers essentially zero resistance to coercion and weak resistance to other forms of fraud. Voting by mail also usually relies on paper ballots, which can seriously limit accessibility. For these reasons, it is unclear whether voting by mail will continue to grow in popularity, and few researchers have investigated its usability.

(For additional voting system usability studies, see the online Supplemental Material.)

After more than a decade doing research on voting systems in collaboration with election officials, I have learned that elections are dramatically more complex and challenging to manage than most people realize. It is no easy task to maintain security and accessibility while also keeping things manageable for election officials, who have to navigate a maze of idiosyncratic voting laws and customs.

Designing usable voting systems requires more than just people with expertise in accessibility and usability. It requires collaboration between people with expertise in election administration; computer security; certification and legal compliance; auditing; and, of course, usability and accessibility. What's more, designing an effective system involves many trade-offs. Because of differences in election laws, local budgets, and demographics, it is unlikely that a one-size-fits-all approach will be effective. Instead, different jurisdictions will require different systems, so designing a usable voting system is a problem that will likely need to be solved multiple times.

Building on the research produced by Caltech/MIT, ACCURATE, and other groups, two collaborative efforts to build better voting machines

are currently under way: the Los Angeles County (California) Voting Systems Assessment Project (VSAP; http://www.lavote.net/vsap/) and the Travis County (Texas) STAR-Vote project. (STAR stands for *secure, transparent, auditable,* and *reliable.*)[17] These two jurisdictions have different constraints in terms of election law, demographics, and resources. Nevertheless, both have brought election and voting system experts together to share their expertise, and the systems they are building share some major design features. Both will use a DRE user interface similar to the Center for Civic Design's Anywhere Ballot (http://civicdesign.org/projects/anywhere-ballot/) to support usability and accessibility, and both will produce a paper record to ensure the system is secure and auditable. Both projects are also committed to usability testing. Preliminary usability data from the VSAP project are available at http://www.lavote.net/vsap/research, and usability testing for the STAR-Vote project is under way at Rice University. If these systems ultimately prove successful, other jurisdictions may use Travis County's and Los Angeles's collaborative processes as models, and those with circumstances similar to those of Travis County and Los Angeles may adopt the systems themselves, although this is still years away.

Today, many of the DREs purchased in the early 2000s with HAVA funds are only a few years away from the end of their life cycle, and election officials are watching the Los Angeles and Travis County voting system development collaborations with keen interest. Further, many election officials are beginning to understand how behavioral science can help improve voting systems for their constituents.

It is the job of security experts and election administrators to worry about keeping ballots safe; it is partly up to behavioral scientists to ensure that what is recorded on those ballots accurately matches voters' intent. Without that, all the security machinery in the world does not guarantee the integrity of American elections. For citizens to trust in the elections, they have to be able to trust that voting systems are user-friendly. Behavioral science has a key role to play in ensuring that they are—thus securing the integrity of U.S. elections.

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supplemental material

- https://behavioralpolicy.org/publications/
- additional references

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report

Behaviorally informed policies for household financial decisionmaking

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abstract

Low incomes, limited financial literacy, fraud, and deception are just a few of the many intractable economic and social factors that contribute to the financial difficulties that households face today. Addressing these issues directly is difficult and costly. But poor financial outcomes also result from systematic psychological tendencies, including imperfect optimization, biased judgments and preferences, and susceptibility to influence by the actions and opinions of others. Some of these psychological tendencies and the problems they cause may be countered by policies and interventions that are both low cost and scalable. We detail the ways that these behavioral factors contribute to consumers' financial mistakes and suggest a set of interventions that the federal government, in its dual roles as regulator and employer, could feasibly test or implement to improve household financial outcomes in a variety of domains: retirement, short-term savings, debt management, the take-up of government benefits, and tax optimization.

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Core Findings

What is the issue?
Classical economics predicts agents will act rationally. However, US households often make sub-optimal financial decisions. Information asymmetries, low incomes, and bias are some of the reasons why households struggle with financial decisions in domains that include retirement savings, short-term savings, debt management, and social welfare benefits.

How can you act?
Selected recommendations include: 1) Reminding and encouraging IRS tax filers with a history of refunds to make concrete plans about depositing these into savings accounts 2) A CFPB-led and tested clear recommendation system that collects basic information from prospective mortgage borrowers to output the best options

Who should take the lead?
Behavioral science researchers, policymakers across agencies dealing with household finances

At the end of the first quarter of 2016, U.S. households held $102.6 trillion in assets: $71.1 trillion in financial assets and $31.5 trillion in tangible assets, mostly real estate. Offsetting these were $14.5 trillion in household liabilities, mostly home mortgages ($9.5 trillion) and credit card debt and other loans ($3.5 trillion).[1] These statistics are the aggregations of the myriad decisions that individuals and households make almost every day: how much to spend versus save, whether to pay with cash or credit, how to invest, whether to rent or own a home, what type of mortgage to choose, how much and what types of insurance to get, whether to attend college and how to finance it, whether to pay bills in full and on time, whether to claim social welfare benefits, how much to work and earn, and so on.

These decisions are made amid an array of regulations meant to shepherd the U.S. economy fairly and efficiently. The alphabet soup of federal organizations that oversee these economic activities includes the Consumer Financial Protection Bureau (CFPB), the Federal Reserve Board (FRB), the Office of the Comptroller of the Currency (OCC), the National Credit Union Administration (NCUA), the Federal Deposit Insurance Corporation (FDIC), the Department of Housing and Urban Development (HUD), the Securities and Exchange Commission (SEC), the Department of Labor (DOL), the Department of Education (DOE), the Department of Health and Human Services (HHS), the Social Security Administration (SSA), and the Internal Revenue Service (IRS). With a workforce of over 4 million people,[2] the federal government also plays an important role as an employer.

Against this backdrop, a growing body of evidence documents widespread and avoidable errors made by consumers in a variety of domains, some with significant financial consequences.[3–15] In this article, we focus on behaviorally informed policies that the federal government could introduce and test in the coming years to improve consumer financial outcomes across five fraught domains: retirement, short-term savings, consumer debt, take-up of government benefits, and tax optimization.

Behavioral Factors That Contribute to Financial Mistakes

Many intractable economic and social factors—from low incomes and limited financial literacy to fraud and deception—contribute to the difficult financial circumstances many households face. But poor financial outcomes also result from an array of psychological tendencies that may be countered by policies and interventions that are both low cost and scalable. We highlight here three tendencies that commonly compromise consumer financial welfare.

Imperfect Optimization

Consumers are not always the fully rational agents depicted in classical economic models. It can be difficult, if not impossible, to correctly calculate the trade-offs between the different alternatives that characterize many financial decisions.

The most important determinant of outcomes is the set of options consumers decide to evaluate, known as the *consideration set*.[16–17] Many mistakes stem from either considering bad financial options or failing to attend to better ones.[18–20] For example, many home buyers do not do any comparison shopping when they apply for a mortgage; they simply go with the first financial institution they contact, which may not necessarily be the best option.[21]

Meanwhile, the financial options people do evaluate will have an array of different attributes that must be taken into account—for instance, various interest rates, fees, or time horizons. In reaching a decision, consumers may weight these factors inappropriately. For example, influences such as advertising may lead them to attach too much significance to relatively unimportant attributes, such as past returns on investments, and too little importance to more critical features, such as fees. Past history, such as directly experiencing the adverse effects of a decline in housing prices, may also influence the weight given to an option's attributes.[6,22–26] In some circumstances, people actively avoid information that would help them make better decisions.[27]

Even if consumers have all the information relevant to a choice and correctly weigh all attributes,

they may nonetheless be unable to appropriately evaluate their options. For example, they may understand that the interest rate is important when deciding whether to save or borrow, but because of limited financial literacy, they may be unable to accurately assess the implications of compounding. This may lead them to extrapolate linearly rather than exponentially, resulting in their underestimating how much they will gain in savings or owe to a lender in the long run.[28–31]

The combination of limited financial literacy and complicated choices can also result in inattention, internal conflict, the application (and potential misapplication) of simplifying heuristics, and avoidance.[32–36] Inaction in the face of complexity is itself another common financial mistake.[37]

Biased Judgments & Preferences

Consumers who have both the knowledge and the time to make effective financial decisions may still be swayed by imperceptible psychological biases that favor certain outcomes over others. Numerous studies show that individuals give more weight to potential losses than to equivalently sized potential gains.[38–41] They also give disproportionate weight to present over future outcomes.[42,43] Further, they overweight very low–probability events relative to higher probability ones.[44] Consumers' choices vary with how a decision or its attributes are framed and the order in which different options or attributes are presented and considered.[38,45–48] Individuals focus on limited local trade-offs instead of broad outcomes, leading to inefficient spending, borrowing, and investment outcomes.[49,50] Their choices are also swayed by their emotional state and seemingly irrelevant factors, such as whether the weather is good or bad.[51,52]

Sensitivity to Social Context

Finally, social context may affect consumers' financial decisions. Individuals may look to the choices others make for guidance about what is best for them, and they may be motivated in part by how others perceive their decisions. They may evaluate their own outcomes not in absolute terms but instead relative to the outcomes of others. Employees may interpret the default savings rate for a 401(k) or other employer-sponsored retirement plan (the fraction of a paycheck to be saved unless the employee chooses a different contribution rate) as a recommendation from their employer about the appropriate savings rate.[53] Consumers may place too much trust in financial advisors, failing to appreciate that certain advisors may be motivated in part by self-interest when they make recommendations.[54–55] Conversely, financial mistakes can also stem from lack of trust. For example, willingness to invest in the stock market has been tied to the level of overall trust in an economy,[56] yet failure to invest in the stock market has been widely characterized as a mistake because investors forego the higher average returns that generally come from investing in equities versus, say, bonds or certificates of deposit.[7] Fear of institutions and social stigma may deter people from claiming financial benefits to which they are entitled, such as welfare, disability, and unemployment insurance benefits. If consumers look to financially capable peers for guidance, they may gain valuable information that helps to counter the problems that arise from imperfect optimization and be encouraged to adopt better financial behaviors.[57,58] But social comparison can also create a sense of envy or discouragement that can deter people from engaging in better financial behaviors.[59–61]

"social context may affect consumers' financial decisions"

Interventions to Limit Financial Mistakes & Improve Consumers' Financial Outcomes

Improving Retirement Outcomes

Many critical decisions affect financial security in retirement. When should an individual retire from the workforce? When is it best to claim Social Security? How much money should be saved for retirement? How should money be invested for and dispersed during retirement? Is a reverse mortgage or long-term care insurance necessary? How should health care coverage and other expenditures be managed so that

a retiree's money lasts throughout his or her remaining lifetime?

For many individuals, the question of how to save for retirement is particularly daunting and subject to many of the behavioral barriers described above. Several behaviorally informed strategies can mitigate these psychological biases and have already been successfully implemented at scale to increase retirement savings, including automatic enrollment, active decisionmaking approaches that encourage immediate action, and simplified savings plan enrollment options. For federal employees and others working for eligible organizations, automatic enrollment in an employer savings plan such as a 401(k) both simplifies the decision about whether to save and forestalls procrastination.

There is, nonetheless, room for improvement. In 2015, an intervention by the White House Social and Behavioral Sciences Team (SBST), in collaboration with the Department of Defense, tested an active choice approach[62] coupled with a "fresh start" decision moment to increase savings plan participation.[63] In this case, the fresh start decision moment occurred whenever an employee changed military bases. At that juncture, employees were prompted to make an active choice about enrolling in the federal government's Thrift Savings Plan, a retirement savings plan for federal workers.[64] The federal government could build on this initiative by introducing other complementary features that encourage savings. For example, the Thrift Savings Plan enrollment form for military personnel[65] offers eight different contribution options (for allocations of basic, incentive, special, and bonus pay to either pretax or Roth accounts). Many individuals might find a predesignated default option—for example, "Check here to direct 5% of your basic pay to a Roth account invested in a target retirement fund"—easier to evaluate than this multifaceted choice.[66] Other fresh start decision moments, including the beginning of a new calendar year, milestone birthdays,[67] pay raises or promotions, or even open enrollment for health insurance, could be used to direct attention to saving for retirement. Imagine a prompt an employee might receive on paying off a retirement plan loan: "Check here to increase your monthly savings contribution by the amount of the loan payment."

One difficult aspect of the retirement savings decision is whether to save on a pretax basis or with after-tax contributions to a Roth account.[68] In savings plans where both options are available, the default is to contribute on a pretax basis, although many employees would be better served by saving on an after-tax basis. The government could test two approaches to optimizing the selection of the option best suited for an individual's situation. One study would pilot a differentiated default: Employees for whom a Roth account is likely the better option are offered that account type as a default, while employees for whom a pretax account is likely more appropriate are offered the pretax account as a default. Another approach would provide employees with checklists that enumerate the reasons one might prefer to save on a pretax basis and the reasons one might prefer to save on an after-tax basis;[69] this could mitigate the effects of biased judgment and some of the other psychological tendencies discussed above.

Financial security in retirement is also affected by when individuals decide to start receiving Social Security. Individuals can claim benefits as soon as they turn 62, but waiting to take benefits can substantially increase the monthly benefit received.[70] Whether it is best to start receiving benefits at age 62 or to delay depends on a variety of individual factors, such as how long one expects to live. This is another instance where a preference checklist could help.[69] The SSA could pilot such an approach with older federal employees as part of the annual benefits statement sent to workers, on its website, or as part of the Social Security application process. The DOL could facilitate tests of the same strategy with private-sector employers.

Individuals must also decide how to transform their accumulated savings into resources for consumption once they reach retirement. One way is to purchase an annuity, a financial instrument that, in its simplest form, guarantees a regular monthly income to an individual for life or a set term. Social Security is essentially an annuity provided by the federal government,

but individuals can purchase an annuity from an insurance company to provide an additional source of secure income. These annuities come in many different forms and with a variety of features that can be difficult to evaluate and compare. For example, does the annuity payment increase over time with inflation and, if so, by how much? Does the annuity provide a survivor benefit and, if so, how large is that benefit and how long does it last? Whether to buy an annuity and what features to choose are perhaps the most complicated financial decisions that most households will make.

In its role as an employer, the federal government is in a position to pilot different approaches to help employees make decisions about whether and how to transform their savings into retirement annuities. Successful approaches could then be used as models for other employers more broadly. Interventions that might be appropriate include providing employees who are nearing retirement with preference checklists that summarize the reasons for and against purchasing an annuity, as well as incorporating in their quarterly statements information on how much monthly retirement income their savings will generate.[71–73] It may also make sense to frame the decision in ways that highlight the potential value of having annuity income to supplement Social Security. The government could, for instance, emphasize the value of an annuity in ensuring that individuals do not outlive their financial resources while de-emphasizing how long an individual would need to live to get a positive return.[45,74–77]

Saving for Short-Term Needs

Individuals have many reasons to save other than for retirement. They face known expenses for which they can plan, like the down payment for a house or college tuition for their children. They also face unknown expenses, like unanticipated car repairs or medical bills. Individuals struggle with both types of savings. For example, despite placing a high value on a college education, fewer than half of families are saving for this known expense for their children.[78] Similarly, less than half of households report being able to cover an unexpected $400 expense without borrowing or selling possessions.[79] Many touch points can be leveraged to facilitate short-term savings. We focus on two areas where the government might have the most success: influencing the investment of tax-time savings and utilizing the federal government's role as an employer.

Tax time is a particularly potent touch point: It presents a unique opportunity for asset building, because many households receive large refunds, sometimes accounting for as much as 30% of their annual income.[80] Interventions that facilitate or encourage saving a portion of an individual's refund at the time of tax filing do increase savings.[81,82] But such interventions may be more effective if they include communications well in advance of tax season, because consumers often mentally allocate their anticipated refunds prior to filing.[83,84] One strategy would be for the IRS to remind tax filers who have received a refund in the past that they can directly deposit a portion of their refund into a savings account and then encourage them to make a concrete plan around how much of their future refund they would like to save. To increase the salience of tax time as a saving opportunity, the government could also frame tax time as a fresh start moment and include a preference checklist to reinforce the reasons to save.[63,69,85]

As the nation's largest employer, the federal government is well positioned to help its employees improve their financial health and serve as a model for other employers. For example, when employees are hired, the government could facilitate opening a savings account for emergencies for new employees who do not already have one. Also, the Treasury Department could redesign the federal government's direct deposit sign-up form to facilitate and promote depositing a portion of each paycheck directly into a savings account.[86] Different approaches that may help include framing direct deposit into both a checking account and a savings account as the option best suited for most employees—thus encouraging an active choice about how much of each paycheck to direct into a savings account versus a checking account—and providing a preference checklist that highlights the reasons to save a part of each paycheck.[37,62,69]

$14.5t
value of US household liabilities in 2016

10%
guaranteed savings rate of return offered to deployed military members

$450b
cost of tax evasion in the form of underreported income

"Individuals face difficult and costly decisions when it comes to debt"

Other pivotal life moments include the birth or adoption of a child, promotions, job separation, and deployments for military service personnel; at all these junctures, the federal government can facilitate savings by its employees. For example, when employees add a newborn to their employee health insurance, the government could provide information about 529 college savings plans along with a simplified way of making automatic contributions to such a plan each pay period. As another example, many government employees receive large payouts for accumulated vacation time at job separation. The government could enable an employee to direct a portion of this payout to the employee's savings account through direct deposit.

Finally, members of the military have a unique opportunity to participate in a savings program that guarantees a 10% rate of return while they are deployed. Currently, service members are able to sign up for this program only after deployment. The Department of Defense could design and test a protocol to allow eligible military personnel to sign up before deployment and to highlight the benefits of doing so.

Managing Personal Debt

Individuals face difficult and costly decisions when it comes to debt: whether to borrow, how to borrow, how much to borrow, when and how to repay, and which debts to prioritize when repayment funds are limited.[87] Debts can be categorized by how fast each one has to be repaid: credit cards and payday loans, for instance, are considered short-term debt, whereas mortgages and student loans are considered long-term obligations. Each type of debt creates its own set of challenges for borrowers. Because many consumers make decisions about short-term debt with some regularity, they can potentially learn from their initial mistakes. In contrast, decisions to take on long-term debt are generally made infrequently and often involve sizeable financial sums. As a result, the potential to learn across these borrowing instances is limited, and the financial repercussions of mistakes are potentially large.

We propose a set of behaviorally informed approaches to improve outcomes around both short- and long-term debts, focusing specifically on some of the major sources of debt that have received a lot of public scrutiny as of late—credit cards, payday loans, mortgages, and student loans—although many of the same approaches could be applied to a wide range of debt products.

Credit Cards. Several obstacles stand in the way of effectively managing credit card debt. One is the difficulty of figuring out the true cost of credit in the face of the many different types of fees (annual fees, over-limit fees, late fees, and cash advance fees) and interest rates (teaser, regular, and penalty rates), in addition to incentives from the array of cash-back or rewards programs associated with card use. Other barriers include a poor understanding of the effects of compound interest and a culture that promotes spending rather than saving. Interventions that could facilitate better decisionmaking include visualization tools to help consumers see the effects of compound interest and calculators that clarify the total cost of purchases under different repayment scenarios. Borrowers would also likely benefit from real-time notifications about just-incurred charges and upcoming and ongoing fees, which would increase the salience of these costs and help consumers avoid them in the future.[22,30] The CFPB and federal government employee credit unions could test such approaches among federal employees and consumers at large.

Payday Loans. Another problematic source of consumer credit is payday loans, which involve relatively small amounts of money targeted for repayment on the borrower's next payday. Consumers often fail to anticipate that they may be unable to repay their loan when it is due. In that case, they roll over the loan until the next payday, but they must pay an additional fee to do so. These fees can snowball if the loan is rolled

over repeatedly and, in some cases, can even exceed the initial amount of money borrowed. Approaches that could be tested to reduce such repeated rollovers include disclosures at the time of loan origination that highlight the high likelihood of having a future rollover, a worksheet to help consumers make a concrete plan about timely loan repayment, and a policy of encouraging at least partial repayment if full repayment cannot be made.[85,88] A different approach would be to guide consumers to alternative products with lower costs. Banks and credit unions already have substantial information about consumers and are thus well placed to offer competitive products at a lower cost, and some already do. The DOL could also encourage the nascent market for employer-based payday advances to help establish a less onerous alternative to payday loans.

Mortgages. Like credit cards, mortgages differ along many dimensions. Some have an interest rate that is fixed for the life of the mortgage, whereas others have an adjustable rate that changes over time with market conditions. Although 15- and 30-year mortgages are the most common, the duration of residential mortgages can vary from 5 to 40 years. Some allow borrowers to pay an up-front cost, or *points,* in exchange for a lower interest rate. And all mortgages come with a variety of different costs that are paid at closing. These different features can make finding the best mortgage difficult. To reduce the barriers to comparison shopping and appropriate mortgage selection, the CFPB could develop and test a simple and clear recommendation system that would collect basic information from borrowers and then present them with a small number of options best suited to their needs. The output could include a "people like you" estimate of the likelihood of defaulting on a proposed loan. The recommendation system could also include a feature to help consumers assess when refinancing would actually be worth the cost.[89,90] HUD, along with bank regulators, could then test various approaches to making this system broadly available and widely used by home buyers.

Student Loans. Although loans for college can be a good investment, many students fail to distinguish between what they can borrow and what they should borrow. They are poorly attuned to the expected salary associated with degrees from different schools and different majors. In many cases, they borrow money to go to school, fail to complete a degree, and are then saddled with debt but without the benefits of the higher pay that comes with graduation. There is tremendous potential for interventions that can help students understand the financial benefits they are likely to receive from their college experience and determine a manageable level of debt.

> "millions of eligible households fail to claim what can be substantial benefits"

The DOE could expand its College Scorecard website[91–93] to incorporate information about the job and salary outcomes for nongraduates and graduates, stratified by college major.[94] The CFPB and the DOE could develop and test the effectiveness of dynamic budgeting exercises, like the Iowa Student Loan Game Plan, that allow students to estimate college costs, monthly living expenses, student loan payments, and postgraduation salaries to help them evaluate how much they can afford to borrow.[95] The DOE could also test different types of choice architecture—ways of structuring a decision process and presenting choice options—to determine which approaches work best for helping students decide how much to borrow and which repayment plan is most appropriate for their situation. The presentation of repayment options might be tailored to particular colleges and majors and incorporate dynamic budgeting systems to help students assess whether their expected monthly income after graduation will be able to cover the required repayments.

Improving Take-Up of Benefits for Low-Income Households

The government offers important financial assistance to low-income households. Yet each year, millions of eligible households fail to claim

what can be substantial benefits from programs such as the earned income tax credit (EITC), the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF), and the Supplemental Security Income program (SSI).[96,97] Economists have traditionally attributed this failure to the time and effort associated with program application or the social stigma of participation.[98] Recent evidence, however, suggests that low take-up, particularly among the very poor, may also be due to psychological frictions, such as a lack of program awareness, confusion about benefits and eligibility, and administrative complexity.[99–101]

One strategy to overcome these behavioral barriers is for agencies to market eligibility and enrollment instructions through simple and repeated communications aimed at those who are potentially eligible for given programs. Some agencies have found, for instance, that repetition of messaging, prominent declarations of likely eligibility and benefits, and clear enrollment instructions have increased participation. Using such methods, the IRS has increased EITC claiming by eligible individuals.[99]

A second strategy is to leverage existing program touch points, cross-promoting other programs for which individuals might be eligible. For example, the IRS could promote and provide information about student loan eligibility when individuals with appropriately aged children file their taxes.[100] The Centers for Medicare and Medicaid Services could communicate likely eligibility for the EITC and other social welfare programs to low-income individuals enrolling for health insurance through the HealthCare.gov marketplace. Such cross-promotion could be especially beneficial for targeting EITC nonclaimants who might otherwise not file a tax return.

Finally, given the potential limits to even the most adeptly designed marketing and education schemes, the federal government could bypass administrative hassles altogether and automatically enroll individuals when both appropriate and feasible. For example, rather than mailing notices to eligible tax filers about unclaimed EITC benefits, the IRS could instead simply mail nonclaimants a benefit check.

Improving Tax Outcomes for Individuals & Government

Decisions about income taxes, such as how much of one's pay to withhold throughout the year, affect both household finances and the federal government's budget. Some people view overwithholding of taxes as a useful commitment device to ensure that they save. Others prefer to get a smaller refund and have more income available throughout the year. Still others owe substantial additional taxes at year-end because they have too little withheld from their pay.

Unfortunately, the relationship between the allowances claimed on IRS Form W-4 (which determines the rate at which employers withhold taxes) and the amount of money likely to be owed or refunded in April is not at all transparent to most taxpayers (including the authors of this article).[102] The IRS would provide a great service if it redesigned the W-4 to help taxpayers better match their withholding with their ultimate tax liability. The W-4 could also highlight and encourage usage of the online withholding calculator hosted on the IRS website.[103] Further, the IRS could communicate with taxpayers who either have very large refunds due or owe additional taxes to help them calculate a withholding rate better aligned with their actual tax liability for the upcoming tax year.

Having too little tax withheld from each paycheck and owing additional tax when returns are due can encourage tax evasion by spurring people to underreport income, be more aggressive in claiming deductions, or not file at all.[104] Tax evasion in the form of underreported income costs the federal government over $450 billion annually and puts evaders at risk for prosecution. Proposed remedies for this tax gap, such as devoting additional resources to enforcement, are typically expensive.[105] However, small changes to tax forms, informed by behavioral science, may increase compliance at little added cost. For example, tax returns currently require taxpayers to attest that the information provided in the return is true and accurate at the end of the form, after they have already decided what income to report and what deductions to claim. Experimental research suggests that signing at the beginning of a form rather than at the end

of it can make moral standards salient, reducing subsequent lying.[64,106] Tax returns could easily be modified to incorporate this insight, and the IRS should consider testing this approach. Income underreporting can also be addressed by asking more direct questions. Taxpayers can currently hide income that is not reported on a W-2 or 1099 by not adding that amount to their documented income, thereby lying by omission. Tax returns could instead directly ask whether taxpayers earned income that was not reported on a W-2 or 1099 and require an explicit yes or no response. Lying by commission (falsely stating that no unreported income was earned) would likely be more distressing (and thus less probable) than lying by omission.[107,108]

Farther-Reaching Actions

The interventions described above could be implemented by the appropriate agencies in relatively short order under existing laws and regulations. A number of additional behaviorally informed policies could improve financial outcomes for households but would require legislative changes or a longer time frame. For instance, retirement savings could be facilitated through legislation mandating automatic employee enrollment in a retirement savings plan, as has recently been instituted in the United Kingdom. Legislation at either the federal or the state level is also needed to allow firms to automatically enroll employees into a nonretirement savings account or to permit savings accounts to come with prizes, another approach used to facilitate short-term, nonretirement savings in other countries.[109,110] Requiring that part or all of a tax refund go to savings could help households better budget for anticipated future expenses, such as a summer vacation or back-to-school clothes for kids, or to meet unexpected expenses, such as a car repair, without resorting to costly forms of credit. Enabling a market for experts who help students file for financial aid, much as firms help individuals prepare their taxes, might increase the likelihood of college attendance and completion.[100] Alternatively, simplifying the tax code and the financial aid application process would help individuals make fewer financial mistakes when filing their taxes or seeking funding for college.

One long-term strategy involves creating a universal portal through which claimants can both verify eligibility for and complete enrollment in a range of programs. A consolidated portal might resemble the existing Benefits.gov site but with expanded functionality and a back end supported by the integration of administrative databases currently housed in different agencies. Another solution would be to simplify, standardize, and consolidate benefit programs. For example, having uniform definitions for the terms used in the screening criteria across programs—such as what the term *dependent* means—would be a sensible step toward reducing confusion over eligibility and increasing participation without significantly expanding the number of people who could qualify. Similarly, consolidating and simplifying the child tax credit, the EITC, and dependent exemptions could reduce the tax-filing burden while also facilitating accurate claiming of tax benefits.

Conclusion

Individuals make financial decisions almost every day of their lives. Invariably, some of those decisions are better than others. While many are of little consequence, such as how much to tip a restaurant server, others can have significant long-term implications, such as how much to save for retirement or whether to get a fixed-rate or an adjustable-rate mortgage. Many poor financial decisions are the result of systematic psychological tendencies: failure to comparison shop for financial products, like a mortgage; overweighting the importance of salient characteristics, like past returns, when choosing an investment while underweighting less salient but potentially more relevant information, like fees; and avoiding things that are difficult, such as applying for college financial aid. In its dual roles as regulator and employer, the government could feasibly test and implement many behaviorally informed policies to improve household financial outcomes in a variety of domains. In this article, we outlined several such policies that could enhance financial security in retirement, facilitate short-term savings, help households better manage consumer debt, increase take-up of government benefits for which individuals are eligible, and improve tax outcomes for

individuals and the government. Some of our proposed interventions are low-cost and relatively straightforward and could be implemented under existing laws and regulations. Others would require legislative changes, a longer time frame for design and implementation, or both. Politicians and government regulators can help improve the financial situations of individuals and households by recognizing how financial decisions are actually made and pursuing behaviorally informed policies such as these.

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report

Behavioral policy interventions to address education inequality

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abstract

Children from low-income families arrive at kindergarten already behind academically, do not overcome these gaps during the school years, and are much less likely to attend and graduate from college. Many programs aim to help these children before they enter formal schooling, as well as during their kindergarten through 12th grade years and on the road to and through college; too often, though, the services go underutilized. In recent years, behavioral scientists have designed interventions meant to increase participation in such programs. Rigorous experiments have shown that a number of these approaches work well, enabling students to perform better academically and reach higher levels of education. Here, we propose four more interventions that federal agencies should test.

Castleman, B., Haskins, R., Akers, B., Baron, J., Dynarski, S., Farran, D., . . . Zinman, J. (2017). Behavioral policy interventions to address education inequality. *Behavioral Science & Policy, 3(1),* 43–50.

Core Findings

What is the issue?
Inequality in educational outcomes remains a pressing issue in the U.S., as gaps in academic achievement by family income continue to widen. However, interventions directed into child care and pre-K education, federal student aid, and income-driven loan repayments have demonstrated measurable successes that warrant further attention.

How can you act?
Selected interventions include:
1) Targeting interventions at other federal agencies that reach children, besides the Department of Education
2) Creating a "Quality Child Care and Pre-K Genie" web portal to centralize important information and nudge parents into the best educational choices for their kids

Who should take the lead?
Education policymakers, behavioral science researchers

With some exceptions, existing policies have failed to remedy persistent disparities in educational achievement and the amount of education attained by low- versus high-income children across all ages, from prekindergarten (pre-K) through college. By the time children are 2 years old, gaps in vocabulary development (a factor in later academic performance) are pronounced, with children from more affluent families hearing millions more words than their lower income counterparts.[1,2] Among children born in the early 2000s, gaps in academic achievement by family income were 30% to 40% wider than they were for children born 25 years earlier. And although over half of young people in the top family income quartile earn a bachelor's degree by the age of 25 years, fewer than 10% of their peers from the bottom income quartile do so.

One explanation for these persistent and, in some cases, widening disparities may be too few resources or programs devoted to improving educational outcomes for economically disadvantaged children. At times, however, resources and programs do, in fact, exist but go underutilized. For instance, in communities where low-income families can select schools of higher quality than those to which their children would normally be assigned, a substantial share of eligible families may not opt for the higher quality schools. In schools that offer rigorous courses, such as Advanced Placement classes, academically eligible students from disadvantaged backgrounds may not enroll. Each year, a sizable fraction of college-ready high school seniors does not complete the Free Application for Federal Student Aid (FAFSA)—a requirement for receiving financial aid for college—even though these students would probably qualify for valuable aid on the basis of their family income.

Over the last several years, researchers have designed and rigorously evaluated a wide variety of behavioral strategies that have been proven to increase participation by economically disadvantaged students and their families in programs meant to improve educational outcomes. These interventions have run the gamut in the ages they target and the services they provide—from pre-K children to college students, and from programs that directly educate students to ones that assist with financing. Consider the following examples:

- Sending parents text messages describing concrete activities they could do at home with their preliterate children led to parents engaging in more of such activities and to stronger cognitive performance among children whose parents were randomly assigned to receive the texts.[3]

- Informing parents about assignments their children missed in middle and high school increased parental involvement, student completion of assignments, and student grade point averages several months after the intervention.[4]

- States that changed the default so that all high school students would be required to take a college entrance exam rather than relying on students to voluntarily sign up experienced dramatic increases in the share of students taking the SAT or ACT. In addition, these states saw significant increases in the percentage of students entering 4-year colleges or universities.[5]

- Integrating assistance completing the FAFSA application into the income tax preparation process at H&R Block led to much higher rates of families successfully completing and submitting the FAFSA and, in turn, to higher rates of students receiving need-based federal Pell Grants to help pay for college. The intervention took approximately 8 minutes per family but led to a nearly 30% increase in the share of students who completed at least 2 years of college.[6]

- Sending community college freshmen text messages reminding them to renew their financial aid and offering one-on-one assistance from a financial aid advisor increased the share of students who persisted through their sophomore year of college by nearly 25%.[7]

Also, under the Obama administration, the White House Social and Behavioral Sciences Team (SBST) applied behavioral insights to help more Americans connect to educational resources and opportunities offered through federal educational programs.[8] For example, in a large-scale randomized controlled trial conducted by SBST, borrowers who had missed their first federal loan payment were randomly assigned to receive a behaviorally designed e-mail reminding them that they needed to pay their loans. The e-mail clearly communicated that the borrower had missed a payment, made salient the role of the loan servicer in the loan repayment process, and provided a customized link to each student's loan servicer portal. In absolute terms, the treatment effects were modest—a 0.8 percentage point increase in the share of borrowers making payments within a week following the intervention—but they were nontrivial relative to the control group's payment rate of 2.7%. In a separate experiment, SBST conducted a randomized controlled trial evaluating a messaging campaign to inform borrowers who were delinquent on their payments about income-driven repayment (IDR) options, which allow students to make lower monthly payments when their income is lower. The treatment effects were again modest—an increase of approximately 0.8 percentage point in the share of students applying for IDR options—but, again, the increase was meaningful relative to a control group application rate of 0.2%. Given that failure to repay loans can lead to a variety of negative economic outcomes, steps that facilitate repayment should benefit students.

"steps that facilitate repayment should benefit students"

Future Opportunities for Behavioral Interventions in Education

The evidence base for the potential of behavioral interventions to improve educational outcomes for disadvantaged children is moderately strong and growing, yet federal agencies could do more to put such interventions into action. For instance, although the majority of states now have Quality Rating and Improvement Systems (QRIS), which provide information about the quality of early child care centers, most states have not invested in robust or behaviorally informed strategies to increase the use of the QRIS information by parents and guardians. At the opposite end of the educational pipeline, upward of 25% to 30% of college students who acquire half of the credits they need to earn a degree withdraw before completing their program.[9] To meet state and federal goals for increased attainment of degrees, institutions are increasingly interested in identifying low-cost strategies to support these students in their efforts to graduate.

We propose four behavioral interventions that the federal government and other organizations could institute to help students and their families navigate complex decisions and make more informed decisions that affect their educational success. (To see which team members proposed each specific recommendation below, see the author note at the end of this article.)

Creation of a "Quality Child Care & Pre-K Genie"

Most experts believe that a key factor in the nation's lack of economic mobility, especially for children whose parents are poor, is the relatively low educational attainment of those children. The difference in educational attainment between poor children and more advantaged children has been increasing in recent years and is thought to result in part from advantaged children attending preschools that are of higher quality than the preschools attended by poor children.[10] Low-income families may not be aware of the long-term benefits of their children attending high-quality early learning centers, and they may struggle to identify the attributes of a preschool that are associated with better outcomes for their children.[11] Although states have expanded the child care and preschool quality ratings they provide, the low visibility and complex presentation of the information may limit its impact on family choices, similar to when kindergarten through

"There is every reason to expand this intervention without delay"

12th grade (K–12) districts present school-choice information in hard-to-access ways.[12]

We propose that a website containing extensive information about the quality and characteristics of child care and pre-K programs in a local area—a Quality Child Care and Pre-K Genie—be created. The site would address the described problems by making low-income parents more aware of the benefits to children's development of particular qualities of preschools and give them information about which schools in their area have the qualities they desire and prices they can afford. In particular, the genie would offer easy access to free, up-to-date information on all registered and regulated day care and early learning programs in the user's geographical area, including information on location, operating hours, quality indicators and ratings, fee schedules, and sources of financial assistance. Although the genie would not provide independent ratings of programs, it would display information from such sources as state quality ratings. The theory of change here is that providing parents with free, easily accessible information on their options will improve their ability to select quality child care centers for their children.[12] In turn, the increase in the use of publicly funded care and in the selection of higher quality options will put pressure on lower quality providers to improve their programs.

Nationwide Implementation of a FAFSA Completion Assistance Program

As we mentioned earlier in this article, a large, multisite, randomized controlled trial of a program that provided personal assistance to families seeking help with their tax returns found that fast and convenient assistance in completing the FAFSA greatly increased the rates of completion and submission of the form.[6] Because of the increased rate of FAFSA submission, the program, which had a 3½- to 4-year follow-up period, also produced sizable increases in the rates of students from low- and moderate-income families enrolling in college and completing at least 2 years of college. Compared with youth in the control group, those in the treatment group

- were 24% more likely to attend college in the first year following random assignment (42.3% of the FAFSA group attended college vs. 34.2% of the control group),
- were 29% more likely to attend college for 2 consecutive years (36.0% of the FAFSA group vs. 28.0% of the control group), and
- spent 20% more time in college over the follow-up period (an average of 13.7 months for the FAFSA group vs. 11.4 months for the control group).

One reason this intervention was so effective was that it greatly minimized the hassle costs associated with completing the FAFSA. It capitalized on the fact that families already had the financial information necessary to complete most or all of the FAFSA at hand and offered assistance with FAFSA from a trained professional during an event—income tax preparation—to which families had already dedicated time. This intervention overcame the tendency that many people have to put off complex and onerous tasks, like FAFSA completion, when information and application procedures are complicated and access to assistance is limited.

There is every reason to expand this intervention without delay; if done effectively, it could produce an increase in college enrollment and persistence by low- and moderate-income students that is of national importance. We propose that Federal Student Aid work with the Internal Revenue Service's Volunteer Income Tax Assistance (VITA) program and, if possible, with commercial tax-preparation companies—such as H&R Block and Jackson-Hewitt—to both implement the intervention across the United States and ensure that such implementation adheres closely to the intervention's key features. We also suggest that a randomized controlled trial be embedded in the expansion to determine

whether the sizable effects found in the earlier research are reproduced on this large scale and to investigate whether the impact of the intervention varies across different settings and populations.

Saving Students Money on Student Loan Repayment

Only 39% of college students complete their degree within 4 years, and it is not unusual for students to require 6 or more years. The U.S. Department of Education estimates that about one-third of graduates take longer than necessary to complete their degree.[13] This problem is especially consequential for students from low-income families who must borrow money to attend college, because their debt increases for each additional year they take to graduate. Given that the average annual cost of attending a 4-year college is over $20,000, if students have to borrow to cover a sizable portion of this cost, each extra year could add substantially to their monthly student loan repayments. In addition to the direct costs of extended enrollment, students forgo earnings while they remain in school.

It seems likely that students who borrow to pay for their education do not understand the magnitude of the debt burden they are acquiring, in large part because they have little experience with personal finance. Given adolescents' tendency to privilege present demands over future considerations, it may also be the case that students are not sufficiently weighting the future monthly loan payments they incur with each additional dollar they borrow in the present.[14,15] We hypothesize that many students would make efforts to graduate sooner if the financial consequences of extended enrollment were more salient—in other words, if the future financial consequences of present borrowing decisions were made explicit—and if they had access to clear information about how to stay on track for earning their degree on time.[16]

Because responses to information are often sensitive to framing, we propose that the U.S. Department of Education test several formats for messages to send to student borrowers to help them understand the repayment requirements of the loans they are taking on and the additional impact that borrowing still more to cover additional years of education will have on their repayment obligation. The statements would include projections of total borrowing and monthly repayments as well as links to additional financial literacy resources. We strongly encourage the U.S. Department of Education to frame this outreach in terms of students accessing academic and other support resources to reduce the time it takes to complete their degree so as to minimize the unintended consequence of prompting some students to withdraw from school over concerns about their debt burden.

We encourage the U.S. Department of Education to also study the effectiveness of alternative communication channels (e.g., e-mail, paper mail, text messaging) by randomly assigning the delivery mechanism across all pilot study participants. This design would allow analysts to estimate simultaneously the impact of the communication channel and the effect of framing statements with additional information. After a year, findings on enrollment and repayment should be used to inform the design of the full-scale implementation of this intervention.

Streamlining & Framing Borrowers' Income-Driven Repayment Decisions

The U.S. Department of Education has proposed creating a new student loan repayment web portal that would provide a single point of contact for students with Direct Loans from the federal government who have outstanding student debt.[17] The portal will provide an opportunity to test behaviorally informed methods of increasing borrower understanding and uptake of beneficial repayment options. We propose leveraging the portal to help increase awareness and simplify the use of existing IDR options for borrowers with outstanding federal student loan debt. Our proposal consists of two parts.

First, the portal would provide nudges about income-driven repayment options—such as visual representations of potential savings under various IDR options—customized to reflect the circumstances of each specific borrower. For

2 y.o.

age at which vocabulary development becomes pronounced according to differences in a family's income level

39% of college students complete their degree within 4 years

30%

increase in share of kids who completed at least 2 years of college after their FAFSA application was tied into families' income tax preparation

"families and children are becoming increasingly saturated with information"

instance, one approach would be to emphasize the potential costs of inaction (a loss framing) when a student fails to actively choose a loan repayment option.[18,19] Another approach would be to highlight information about the choices made by similar borrowers, with the goal of creating a positive social norm around certain repayment options.[20,21] Finally, nudges about IDR repayment options could use goal-based framing and emphasize the specific ways in which borrowers could use the savings they would realize by reducing monthly loan payments.[22,23]

Second, the U.S. Department of Education would collaborate with the Internal Revenue Service to feed income tax data into the new web portal, streamlining verification of income and enriching the calculators to help borrowers make decisions on IDR. This procedure will simplify the loan application process and thereby help applicants overcome a key point of drop-off in IDR applications.[24]

These behaviorally motivated interventions would enhance the impact that centralized communications and collaborations among federal agencies can have on borrower choices and financial well-being.

Guiding Principles

We suggest that, moving forward, the federal government should follow three guiding principles in designing and evaluating future behavioral interventions in education.

One, disseminate behavioral interventions through many agencies that reach children and families rather than focusing on conducting interventions just within the U. S. Department of Education. Of course, the U.S. Department of Education is a logical place to start, but other federal agencies also have programs or resources that directly touch families and their children. The U.S. Department of Housing and Urban Development, for instance, operates housing voucher programs through which it can directly communicate with low-income families, and the U.S. Department of Defense operates various benefit programs that affect soldiers' dependents. Such channels may provide important avenues through which to conduct behavioral interventions, particularly for children early in their educational trajectories.

Two, consider opportunities for intervention throughout the age span, from pre-K through college, rather than focusing solely on post-secondary education. To date, much published work on behavioral interventions aimed at increasing the use of services and programs in education has focused on higher education, although over the last few years a growing number of studies have been conducted in early and K–12 education. We encourage federal agencies to identify and pursue opportunities for behavioral intervention in early childhood education and the K–12 sectors. These efforts could be conducted with the U.S. Departments of Education, Health and Human Services, and Defense.

Three, behavioral designs that extend beyond informational campaigns. We argue for pursuing additional strategies in part because we are concerned that families and children are becoming increasingly saturated with information from various sources. One example would be to change the loan repayment plan default so that borrowers who have selected an income-driven repayment plan are automatically renewed in the plan each year. The current default requires borrowers to actively recertify their participation in income-driven repayment programs on an annual basis.

Conclusion

The White House SBST has shown the way for policymakers to expand the use of nudges in federal programs to increase program

effectiveness not only in education but in other realms as well, such as retirement programs and government efficiency. We have attempted to bring outside thinking to the challenge of increasing the range and impact of behavioral interventions the government could undertake to improve the education of students from low-income families. All four of the recommendations we have presented hold solid promise for helping the nation improve the achievements of these disadvantaged children. If successful, these interventions would reduce poverty and increase economic mobility among children from poor families in the long run.

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Ben Castleman and Ron Haskins coordinated the first draft and revisions to the authors' original text. Others provided the first drafts of the following sections: Creation of a "Quality Child Care and Pre-K Genie" (Rebecca Maynard and Philip Sirinides), Nationwide Implementation of FAFSA Completion Assistance Program (Jon Baron), Saving Students Money on Student Loan Repayment (Beth Akers with Ben Castleman), and Streamlining and Framing Borrowers' Income-Driven Repayment Decisions (Susan Dynarski, Damon Jones, Benjamin Keys, and Jonathan Zinman).

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Blood Sugar Tracker
Tuesday
Before
After
Wednesday
Before
After
Thursday
Before
After
Friday
Before
After

report

A behavioral blueprint for improving health care policy

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abstract

Behavioral policy to improve health and health care often relies on interventions, such as nudges, which target individual behaviors. But the most promising applications of behavioral insights in this area involve more far-reaching and systemic interventions. In this article, we propose a series of policies inspired by behavioral research that we believe offer the greatest potential for success. These include interventions to improve health-related behaviors, health insurance access, decisions about insurance plans, end-of-life care, and rates of medical (for example, organ and blood) donation. We conclude with a discussion of new technologies, such as electronic medical records and web- or mobile-based decision apps, which can enhance doctor and patient adherence to best medical practices. These technologies, however, also pose new challenges that can undermine the effectiveness of medical care delivery.

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Core Findings

What is the issue?
Simply increasing the share of resources devoted to health care does not guarantee successful outcomes. Behavioral science can offer insights and interventions that complement traditional policies to better manage disease and lifestyle; improve the administration of insurance; counter inefficiencies in care; increase medical donations; improve end-of-life care; and navigate new technologies.

How can you act?
1) Corporate wellness programs should incorporate behavioral insights, be evidence-based, and should ideally incorporate experimental components that expand evidence concerning best practices
2) Health insurance should be simplified and standardized, and the design of enrollment interfaces should be informed by behavioral insights
3) Inefficient medical practices should be discouraged through greater use of second opinion programs and through differential insurance reimbursement to encourage provision of high value care.
4) Defaults and active choice should be harnessed to improve end of life decision making as well as organ and blood donations.

Who should take the lead?
Policymakers, Insurance companies, healthcare providers, and employers

Providing access to affordable and quality health care is perhaps one of the most important objectives of an enlightened modern society. As the recent experience of the United States has shown, however, simply increasing the share of resources devoted to health care does not guarantee better outcomes. The United States, compared with other wealthy countries, spends a far greater fraction of its national income on health care, yet its residents have a lower life expectancy at birth, a higher infant mortality rate, and a comparatively high prevalence of obesity and chronic diseases like diabetes.[1] Although outcomes are not uniformly poor, the money that is spent is not helping everyone equally. Longevity and other health outcomes vary substantially between different demographic groups and, for low-income individuals, differ sharply across geographic regions.[2,3] These disparities stem at least in part from poor access to health care: an estimated 28 million nonelderly individuals lack health insurance, and many health services are beyond their reach.[4]

To address the high costs and seemingly low returns on health care spending in the United States, we explore ways that behavioral science can help policymakers improve health outcomes while also containing health care costs. We know the U.S. health care system best, but many of our proposed remedies could help other nations combat similar policy challenges. Although the United States is an outlier in per capita health care spending, health care consumes a substantial fraction of national income in all developed countries. Consequently, long-term cost-reducing strategies, such as those that combat obesity, are of broad interest. We organize our discussion around six key challenges: (a) encouraging healthier lifestyles; (b) expanding enrollment in health insurance; (c) aiding insurance companies in designing, and consumers in choosing, insurance plans; (d) discouraging inefficient medical practices; (e) improving end-of-life care; and (f) encouraging organ, blood, and other medical donations. We also address the potential, as well as the pitfalls, of new informational technologies such as electronic medical records and web- and mobile-based decision aids.

Insights from behavioral science have delivered significant gains in areas outside of health, such as consumer finance, through surprisingly straightforward innovations. For instance, firms that adopt automatic enrollment in 401(k) plans increase plan participation. Finding similar low-hanging fruit in the medical area has proven more challenging, however. Health care is much more complicated because it involves an unusually wide range of often competing interests, including those of patients, employers, providers, and insurers.[5] Moreover, choosing an optimal health plan is significantly more complex than choosing an optimal retirement plan. In health insurance there is no equivalent to a target date or index fund.

Nevertheless, by drawing on research across the behavioral sciences, we have identified several promising health policy interventions. Wherever possible, we rely on evidence from administrative data or field studies to forecast how these recommendations might affect the real-life behavior and welfare of patients and doctors. Field studies are rare, however, when it comes to health policy, because they face regulatory barriers and are difficult to implement. We therefore also rely on lab experiments and economic modeling to guide our recommendations.

Disease & Lifestyle Management

Many of the health problems facing the United States, as well as other nations, can be traced at least in part to unhealthy behaviors. Habits such as smoking,[6–8] following a poor diet, and leading a sedentary life[9,10] account for up to 40% of premature deaths in the United States, whereas deficiencies in health care delivery account for only 10%.[11,12]

Researchers have tested behaviorally inspired interventions to deal with these problems, including programs that strengthen incentives to exercise,[13] quit smoking,[14–16] and make healthy dietary choices.[17–20] These efforts have yielded some benefits, but the successes have generally been short-lived. One program that was successful in producing substantial short-run weight-loss using behaviorally informed incentives, for example, yielded no long-term benefit,[17]

although another that provided group-based incentives (in which all individuals in a group who lost a target amount of weight each month shared a fixed prize amount) did show a lasting benefit.[21] Other interventions have focused on nudges that do not change incentives, such as nutritional labeling,[22] strategically designed cafeterias,[23] trayless dining, and packages and plates shaped and sized in specific ways[24] (reviewed in a recent meta-analysis).[25]

One promising development in recent years has been the spread of health and wellness programs in large American firms. These employee programs typically feature a mix of initiatives for chronic-disease management, health screening, and lifestyle improvement. They draw heavily on behavioral insights, including the power of small economic incentives, marketing campaigns, and rewards programs, to encourage employee engagement.[26] Although the details of program design, implementation, and take-up vary considerably across firms, the introduction of wellness programs is correlated with increased exercise, healthy eating, smoking cessation, and weight reduction among employees, and some evidence indicates that wellness programs lead to improvements in employee productivity.[27] Researchers conducting future studies should focus on finding the optimal design of initiatives for effecting sustained and cost-effective behavioral change.

We suspect that optimally designed wellness programs and health policies involve coordinated interventions that have the potential to disrupt deep-seated behaviors through a mix of education, habit formation, and social change. For example, there is little evidence that, in isolation, warning labels and educational efforts reduce cigarette use. But in the United States, when these approaches were combined with cigarette taxes, restrictions on advertising, and bans on public smoking, cigarette smoking declined substantially. Seat belt usage also became more widely adopted through such coordinated efforts.[28] Addressing other policy problems grounded in deep cultural and social norms (such as excessive drinking and unhealthy eating) may require a sophisticated coordination of traditional economic policies, including regulations and taxes, with behaviorally informed strategies designed to educate and nudge. Rather than studying the effects of individual interventions, researchers should test interventions that combine behavioral and standard economic elements using large-scale randomized controlled trials.[29]

Health Insurance Coverage & Plan Choice

Improving the administration of health insurance—making it easier for consumers to sign up for the most appropriate policies—offers perhaps the most direct example of how policy based on behavioral science could enhance medical care in the United States.

Insurance Take-Up

A basic problem with access to American health care is that a significant share of people eligible for subsidized health insurance coverage fail to enroll. One-third of eligible adults do not claim Medicaid benefits, and studies have shown that half of those who qualified for coverage from marketplaces established by the Patient Protection and Affordable Care Act (ACA) failed to sign up, opting either to forgo insurance entirely or to enroll in unsubsidized individual plans outside of the exchange.[30–32] Traditional economic models imply that people decide to not enroll because the social stigma and financial costs associated with applying outweigh perceived program benefits. However, recent research offers evidence that barriers to making competent decisions may be responsible for a substantial share of nonparticipation, particularly among the poor.[33] Millions of individuals may forgo potentially valuable insurance coverage because they are unaware of programs, are uncertain that they are eligible, or feel overwhelmed by complex bureaucratic procedures.

Behavioral research offers several strategies for increasing enrollment and take-up of available credits and subsidies. These include simplifying the enrollment process, more aggressively communicating program benefits and eligibility criteria, and providing personalized one-on-one assistance to consumers interested in signing up. Programs could also rely on defaults,

in 2016 **$1 trillion dollars** in healthcare spending is estimated to have been unnecessary

28m

non-elderly individuals who lack health insurance

40%

premature deaths related to poor lifestyle habits

"one radical form of simplification would be to eliminate deductibles and coinsurance"

automatically enrolling people in health insurance unless they opt out.[34] The exchanges of the ACA were designed to simplify plan enrollment and verification of eligibility. These design features may have contributed to shrinking the ranks of the uninsured, but considerable room for improvement remains.[35]

A more structural approach to increasing enrollment in Medicaid, the Children's Health Insurance Program (better known as CHIP), and other health plans available through the government is to create a universal portal that could identify programs individuals are eligible for (by asking them a series of targeted questions) and through which individuals could enroll in federal and state benefit programs. A single, intensively marketed gateway could dramatically increase applications and enrollment for several benefit programs, particularly those available to the poor. Such a portal might resemble https://www.benefits.gov, an existing umbrella site for federal benefits.

Health Plan Choice

A second policy problem is that those who do enroll in insurance programs often make financially disadvantageous choices. Consumers are increasingly being directed toward exchanges that require comparisons across plans differing in financial cost sharing (deductibles, coinsurance, copayments, and maximum out-of-pocket expenses) as well as in nonfinancial dimensions (such as the breadth of the network of eligible providers and the insurer's reputation for processing claims). The evidence suggests that many consumers do not grasp the fundamental building blocks of insurance, and hence cannot possibly make an informed decision.[36] A number of studies have documented that in both employer- and government-sponsored exchanges enrollees often choose plans that either cost too much or provide too little insurance coverage given their circumstances.[37–39] Other studies hint that consumers may not recognize that the *bronze, silver, gold,* and *platinum* labels used in the exchanges of the ACA were designed to communicate differences in the degree of cost sharing rather than differences in the breadth or quality of coverage (that is, a bronze plan may be optimal for someone who is healthy). As a result, such choice architecture may not help enrollees choose optimal plans.[40,41] The economic consequences of potential mistakes in plan choice are significant, borne disproportionately by those with low incomes, and largely avoidable.[33,38]

Behavioral research offers strategies for helping consumers better navigate the complex decisions required for selecting the best insurance plans. These approaches include decision aids that consumers are strongly encouraged to use, clearer interfaces that highlight the tradeoffs inherent in choices, or even personalized "smart" defaults (for instance, automatically enrolling individuals in a plan with a deductible level appropriate to their needs).[42] A more promising approach, however, is to make the plans sufficiently simple that even poorly informed consumers can understand them.[43] This goal could be achieved through regulations mandating simplification and standardization of policies, much as credit card statements were changed by recent financial reforms.[44]

One radical form of simplification would be to eliminate deductibles and coinsurance, the two aspects of health insurance that most confuse consumers. The resulting copay-only plan would have fixed prices for different services, which is closer to the setup that consumers encounter when shopping for most other goods. (Such a plan would also incorporate an out-of-pocket maximum.) There is, of course, a concern that individuals insured by policies lacking deductibles will consume too much health care, leading to higher premiums for the insurance pool as a whole. But at least one health insurance company has been selling such policies for years—a sign that this route is financially viable.[45]

Efficient Use of Medical Care

The fee-for-service system of medical reimbursement, which is dominant in the United States, leads to overprovision of services by doctors and hospitals because it creates incentives for providers to perform more tests and procedures.[46] Unnecessary tests and treatments are estimated to account for nearly 1 in 3 dollars spent on medical care in recent years.[47] This implies that in 2016 alone, roughly $1 trillion of health care spending was wasted through overuse. Moreover, likely tens of thousands of patients were needlessly subjected to anxiety, invasive procedures, and the risk of medical complications.[48]

Currently, there is no consensus on how to limit unnecessary and inappropriate medical care. Many ideas have been proposed, but few seem likely to have a large impact. High-deductible health plans, for example, are widely used and have been shown to lower total spending. However, they are blunt instruments directed at consumer behavior and do not necessarily target the procedures most prone to overuse by physicians or least useful to patients.[49,50] More promising are accountable care organizations (ACOs), which, among other characteristics, are paid on a per capita, rather than per procedure, basis for a defined group of patients. ACOs have, however, experienced challenges in implementation[51] and so far have realized only modest savings.[52] They have, nonetheless, yielded improvements in quality measures and patient satisfaction and have reduced the number of procedures performed.[53–55] In the remainder of this section, we focus on three alternative possibilities for health cost reduction that we believe can be informed by behavioral strategies: reducing provider conflicts of interest, increasing the use of second opinions, and analyzing the costs and benefits of treatments and tests.

Provider Conflicts of Interest

Although correcting misaligned incentives created by fee-for-service arrangements is a daunting challenge, there is considerable scope for eliminating or reducing conflicts of interest among physicians. Current regulations that limit sales visits (a practice known as *detailing*) by representatives of pharmaceutical and medical device companies do not go nearly far enough in restricting such practices. Pharmaceutical firms continue to spend heavily on marketing, and the large majority of American physicians receive some sort of financial benefit from the industry (often in the form of food in the workplace).[56] Ample research finds that even small gifts can distort decisions, in part because physicians are not aware of their influence.[57] Essentially all researchers working in this area agree that such gifts should be prohibited.[58,59] Indeed, both Vermont and the Veterans Affairs health system ban pharmaceutical and medical device companies from providing meals to physicians. Recent data show that policies that constrain gifts have their intended effect: physicians subject to such regulations are less likely to prescribe off-label and more likely to prescribe generics.[60,61]

Improving transparency is another tactic that can have a significant impact. Research suggests that individuals who are forced to disclose conflicts of interest are less likely to accept gifts or compensation that they would be required to disclose.[62] Transparency policies often also have unexpected benefits, such as enabling scientists and the press to do more comprehensive investigations. However, no research has shown that patients benefit directly from receiving information about physician conflicts and, indeed, the opposite may be the case.[63,64] Targeted transparency rules may thus require disclosure not directly to patients but to a centralized database, which could be automated and not take up valuable physician time.

Increased Use of Second Opinions

Second opinion programs (SOPs) offer a potentially quick, simple, and economical way to reduce inappropriate and unnecessary medical care in the United States. SOPs were popular for surgical procedures in the 1970s and early 1980s but fell out of favor despite promising evaluations.[65–67] However, technology that has since become available, such as electronic medical records, has the potential to vastly increase the efficacy and cost-effectiveness of SOPs. These programs rely in part on the idea that most people would prefer not to undergo surgery that is, at best, unlikely to benefit them and, at worst,

harmful. Moreover, SOPs can be implemented quickly and independently of other reforms.

A successful SOP would target tests and treatments that studies suggest are often of questionable value.[68] Obvious candidates would be costly surgical procedures such as knee or back operations,[69,70] which appear to offer medical benefits only in a fraction of the cases for which they are performed. Most SOPs have been entirely voluntary, resulting in low usage rates. One way to encourage more patients to obtain second opinions would be to schedule them by default for specific tests and procedures and to offer incentives for taking advantage of them (for example, waiving the copays for the second opinion and perhaps providing a discount on premiums). To minimize conflicts of interest and tacit collusion among health professionals practicing together, second opinions, where feasible, should come from physicians outside of the provider network of the original doctor recommending the test or treatment.

In the Netherlands, a program mandating double evaluations of mammograms (by two independent experts, with a procedure for adjudicating disagreements) has led to a false positive rate half that of the United States—and with very few false negatives.[71] This SOP has resulted in substantial cost savings from avoiding unnecessary follow-up testing and treatment and spared women from needless anxiety and surgical intervention.

Evaluating the Merit of Tests & Treatments Using Cost–Benefit Analysis

Perhaps the most obvious approach to reducing excess health care utilization is for public and private insurance to stop covering tests and treatments of dubious value. In the United Kingdom, the National Institute for Health and Care Excellence (NICE) publishes guidelines that determine the National Health Service's coverage of health care technologies for specific diseases and conditions. Such an agency is essential for making impartial, credible decisions that trade off costs and quality. In the United States, the Agency for Healthcare Research and Quality (AHRQ) played a similar role after its creation in 1989, but it encountered stiff opposition from pharmaceutical companies and physician groups when it put forward proposals that would have limited funding for certain procedures and drugs. The agency today focuses primarily on the safety and quality of medical services, rather than the efficacy of specific treatments.

Any NICE-like agency in U.S. medicine should seek to avoid some of the mistakes that can occur when decisions rely only on cost–benefit analysis. For instance, making cost–benefit analyses based on QALY (quality-adjusted life year, a measure that assesses the value of medical interventions) can produce recommendations that are widely viewed as misguided.[72] A QALY analysis might suggest that one health condition is 10 times as bad as another. Applying these numbers to policy suggests that if costs to treat each condition are similar, policymakers should judge it equally valuable to treat 10 people with the milder condition or one person with the more severe condition. Yet, given a choice between these two alternatives, an overwhelming proportion of survey respondents expressed a preference for treating the smaller number of people with the more severe condition. Behavioral science can contribute to better decisionmaking by providing tested ways to elicit public and expert input as to which tests and procedures should be covered, as well as refined methods of converting such inputs into policy recommendations.

End-of-Life Care

By one composite measure of the quality of end-of-life care, the Quality of Death Index, the United States ranks ninth out of 80 examined countries.[73] Although the United States scores well on several dimensions of quality of death (for example, in the availability of palliative care professionals), affordability is an issue in this domain of health care as well. Large numbers of patients end up receiving treatments that are both more costly and more burdensome than desired or expected.

Many terminal patients do not want to undergo painful and unpleasant life-extending measures. When advance directives default to comfort care (versus extending life regardless of the

"communication failures during the terminal stages of illness are a well-documented source of patient anxiety"

discomfort), people tend to choose limited treatment options.[74,75] Avoiding extreme life-saving measures, however, can be hindered by a number of barriers. For instance, health professionals may be reluctant to provide information to patients about end-of-life care if they are uncertain about the accuracy of their prognoses.[76] They also often deliver prognoses that are too optimistic, overestimating the length of survival,[77] and these overoptimistic prognoses discourage patients from opting for comfort options even when the possibility of recovery is remote. In addition, advance directives are only meaningful if physicians adhere to them, which they often do not, in part because many view prolonging life as their professional role. Families, too, may overrule the decisions of the patient, and patients themselves may not update their recorded wishes to reflect changes in goals of care over time.[78,79] Finally, physician–patient communication failures during the terminal stages of illness are a well-documented source of patient anxiety, family distress, and physician burnout.[80]

Behavioral research points to several interventions that could potentially improve end-of-life care. For example, electronic medical records could be programmed to provide prompts that trigger advance care planning discussions between doctors and patients with serious illnesses. Health care systems could provide incentives to increase the number of conversations between doctors and patients about treatment preferences and goals of care. Medicare currently does pay physicians for advance care planning—specifically for discussing with patients advance directives and living wills—although such consultations still appear to occur relatively rarely.[81] In addition, health care systems could further expand the number of physicians trained in palliative care. Regulating bodies could also urge the development of medical school curricula that train doctors in how to best communicate prognostic information and engage in conversations that make patients and family conscious of the emotional pain that can come with highly invasive life-extending measures.

Medical Donations

Donations of blood, plasma, bone marrow, other tissues, and organs can save lives,[82] improve health outcomes,[83] and decrease medical costs.[84] This area is particularly ripe for policy informed by behavioral research, because the logical alternative—financial incentives for donation—is deemed repugnant for many types of donations, and is thus, in many cases, prohibited.[85,86]

For blood donations, studies have shown that social recognition for frequent contributions encourages regular donors to give more often.[87] Gifts and the elimination of financial disincentives for donating (for example, by providing free, convenient parking) also lead to more contributions.[88,89] For organ donation, allocation rules that prioritize giving organs to registered donors or to the next of kin of deceased donors have been shown to lead to more registrations and an increased rate of next-of-kin consent.[90–94]

An opt-out system—in which individuals are presumed to be registered organ donors unless they decline that option—can dramatically increase the number of registered donors,[95] and ultimately, the rate of transplantation.[96] Such a system is common in many countries and was most recently adopted in Wales in 2015.[97] However, an opt-out system raises ethical concerns and the possibility that relatives may be more likely to oppose organ donation if the deceased's wishes remain unclear. Requiring people to make an active choice when they visit the Department of Motor Vehicles might seem to provide an ethical and practical compromise approach, but was found to lower sign-up rates in California.[98]

Further experiments could explore different ways to frame the active choice to become an organ donor. In *enhanced active choice,* for instance, the desired option is worded in a way that encourages choosing that option.[99] In a field experiment in the United Kingdom, emphasizing reciprocity was shown to increase registration

rates compared with a no-reciprocity condition and other framings.[100]

New Technologies to Improve Medical Care

New technologies, such as electronic medical records and digital decisionmaking aids, are taking root in American medicine. These tools can be enlisted to change doctor and patient behaviors for the better.

Electronic Medical Records

Electronic medical records, which are increasingly used by doctors during patient visits, provide a unique opportunity to intervene constructively and systematically in the provision of medical care. They offer relatively easy ways to implement defaults in patient care, although one study found that defaults mainly affected the provision or nonprovision of services that were of marginal value.[101] In an approach somewhat more heavy-handed than a simple default, when the electronic medical record system was set up to request a short, written justification for what was likely to be an inappropriate antibiotics prescription, the incidence of such prescriptions fell by 75% (a mere prompt, by contrast, did not have an effect).[102] Regulations requiring electronic medical record systems to flag inappropriate prescriptions, and asking doctors to provide justifications for their actions, would likely not impose much of a burden but could substantially reduce the number of deaths (and the costs) associated with antibiotics resistance. Physicians have also been found to prescribe generic medicines more frequently when generics are the default in the electronic medical record system, allowing patients and insurers to save costs.[103]

Electronic medical record systems could also help patients comply with their treatment plans. Such systems, for example, can provide alerts to physicians if prescriptions are not filled on schedule (which suggests a lack of adherence to a drug regimen). Electronic medical records could also be used to send automatic notifications to patients, such as a message defaulting them into a particular appointment time, allowing them to opt out or reschedule. This approach has been shown to increase vaccination rates compared with a letter asking patients to make an appointment.[104] In addition, checklists used during interactions between physicians and patients have been shown to reduce adverse outcomes, including death.[105–108] Integrating checklists with electronic medical records may thus reduce errors.

Electronic medical records are, however, an enormous source of physician dissatisfaction,[109] and interventions of this type should be used judiciously. Like other behaviorally inspired interventions, those that work well in isolation might be less effective or even have perverse effects when combined (for example, excessive numbers of alerts might lead physicians to ignore all alerts).[110] These concerns show the need for extensive field testing of interventions so that such problems can be identified before a new policy is rolled out widely.

Beyond their ability to influence physician behaviors, electronic medical records may also provide information that could be analyzed using big data methods to obtain new insights on diseases and treatments. Such applications are currently stymied by the proliferation of different systems that cannot talk to one another, as well as by barriers to data access caused by privacy regulations. Electronic records also offer patients direct access to information such as test results that, in theory, can aid in the self-management of chronic disease and preparation for clinic visits. Unfortunately, many existing patient portals to electronic medical records are not sufficiently user friendly to enable large numbers of patients to access information effectively.[111]

Nonetheless, we believe that physician adoption of information technology, including electronic medical records and diagnostic systems, may turn out to be crucial to the efficient provision of health care services. To date, there is still limited empirical research examining the effectiveness of information technology and how it might be modified to fit the needs of different physicians, patients, and organizational structures. Some research has shown that information technology improves outcomes for certain patients with complex health problems (but not simpler cases).[112] Other work indicates that the

adoption of information technology is correlated with improved process-based care (such as management of diabetics) and that it reduces overtesting.[113] One key issue that remains unanswered is whether information technology's overall impact is productive (for instance, helping physicians perform their jobs more effectively) or nonproductive (for instance, allowing physicians to better take advantage of existing financial incentives without improving the quality of care).

Digital Decision Aids

Web- and mobile-based decision aids—which enable patients to better understand the available treatment options and help doctors explain them—could overcome a long-standing obstacle to optimal treatment: reluctance to question doctors' recommendations. Patients are often unaware of how medical decisions could depend on their personal preferences, partly because they commonly view clinicians as authority figures.[114] Yet, patients who are not adequately informed or engaged in the decision-making process may receive unwanted treatment or overtreatment.[115–117] Moreover, both patients and doctors have cognitive and affective biases that can impair the processing of information and decisionmaking.[118–120] Physicians are often not trained to engage in shared decisionmaking, risk communication, and emotion-focused conversations, and hence they may have difficulty involving patients in these activities, even when they are conscious of the need to do so.[121,122]

Patient decision aids, which provide consumers with treatment options in easy-to-understand language, are a promising tool. They have been shown to increase patient knowledge, improve the accuracy of risk perceptions, align patient preferences with treatment, and strengthen patient engagement.[123] Seven states (California, Connecticut, Massachusetts, Maine, Minnesota, Oregon, and Vermont) now mandate or incentivize (by reducing provider liability) the use of certified, high-quality decision aids—a model other localities should emulate. Additional strategies for improving patient decisionmaking involve providing telehealth or e-health options as spaces for patients to ask questions of providers after having had time to reflect on information they received during an appointment. Other opportunities include the development of systems that automatically trigger appropriate decision aids for patients (for example, e-mailing the patient a relevant link when a diagnosis is entered into the electronic medical record), public recognition of providers for generating and implementing best practices in shared decisionmaking, training of medical students and residents in patient engagement, and efforts to make shared decisionmaking billable and reimbursable for clinical time.[121,124]

> "the most promising behaviorally informed health reform will take the form of structural changes inspired by a deep understanding of psychological mechanisms."

Conclusions

In this article, we highlighted several of the most promising applications of behavioral science to health policy and health care. These proposals target a range of health stakeholders, from consumers and practitioners to the broader insurance system, and emphasize solutions that are feasible in the near term or have long-term potential for improving health outcomes and reducing health expenditures.

In the domain of consumer finance, understanding of how individuals might respond to behaviorally informed policy has benefited greatly from the proliferation of randomized field experiments. The recently created Consumer Financial Protection Bureau (CFPB) has, for example, worked with an issuer of a prepaid debit card to improve savings among those who may not have access to traditional bank accounts.[125] The CFPB's ability to pretest policies has benefited from the authority it has been granted to confer regulatory exemptions to firms that facilitate research on consumer protection.

Such public–private research collaborations are a highly promising development that can bring in substantial resources and expertise at little or no cost to the government. A similar institution in the health domain could greatly extend health policy research by granting regulatory exceptions when warranted. Such an organization could offer waivers to insurance firms, health care providers, and pharmaceutical companies so that these groups could develop randomized controlled trials that explore the effects of policy changes. For example, an insurer might be permitted to recommend insurance plans to customers on the basis of their personal health data, or a drug manufacturer might offer incentives and patient outreach to promote adherence to drug regimens.

Although there is scope for improving the quality of patient and provider decisions through low-touch interventions, such as digital decision aids, simpler information displays, or consolidated enrollment portals, the most promising behaviorally informed health reform will take the form of structural changes inspired by a deep understanding of psychological mechanisms. Examples that we discussed are simplified medical insurance policies (without deductibles and coinsurance), mandated second opinion programs, and active-choice organ donation programs. Such ambitious interventions require significant buy-in by political leaders, health care professionals, and the general public and will necessitate broad engagement among these stakeholders. If buy-in can be realized, however, the proposed set of policies could substantially contribute to improving the health of the public. Our article has emphasized challenges in the U.S. health care system, but many of these proposals should be equally effective in other countries and are independent of the specifics of how health care is organized and funded. Although incentives for physicians and a requirement to obtain a second opinion may be easier to achieve with a nationalized health provision system (as in the United Kingdom), a competitive market of insurance companies (as in the United States) may be better adapted to providing novel patient-engagement tools and corporate wellness programs.

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report

Behavioral science tools to strengthen energy & environmental policy

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abstract

To increase consumers' conservation of energy and other resources, government agencies, utilities, and energy-related businesses can complement regulatory and market-based policies with simple and effective behavioral interventions grounded in extensive behavioral science research. In this article, we review 13 behavioral tools that we find especially promising. Collectively, these tools help meet four behavioral objectives: getting people's attention; engaging people's desire to contribute to the social good; making complex information more accessible; and facilitating accurate assessment of risks, costs, and benefits.

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Core Findings

What is the issue?
Getting people to adopt behaviors that increase energy conservation and reduce costs for the environment requires a multipronged approach. Behavioral science research and insights can complement both market-based and regulatory policies in 13 impactful ways.

How can you act?
Rolling out a program to promote efficiency or conservation? Review this list and make sure you engage your audience as effectively as possible.
1) Reaching out with interventions and information during life transitions, such as when people buy a new house, car, or appliance
2) Choose meaningful, expanded time frames. For example, expressing gasoline costs over 100,000 miles increases preferences for more efficient cars

Who should take the lead?
Behavioral science researchers, policymakers in the environment and energy

Conserving energy and other resources is among the most powerful ways to increase sustainability, reduce pollutants, limit the buildup of greenhouse gases, and otherwise protect the environment. Here, we propose 13 practical, cost-effective, and impactful behavioral interventions, or tools, that policymakers, utilities, energy-related businesses and other organizations could use to increase conservation by consumers. The recommendations all derive from academic research in behavioral science, including several recent reviews related to energy and the environment.[1]

These tools complement regulatory or market-based policies in two ways. First, they would provide additional incentives, other than simply financial ones, to change behavior. Second, they would strengthen regulatory or market-based policies by focusing on what information to present, how to present it, when to reach out with the information, and when to remind people of it.

Broadly speaking, the behavioral tools we recommend can help meet four objectives: get people's attention; engage people's desire to contribute to the social good; make complex information more accessible; and facilitate accurate assessment of risks, costs, and benefits. As shown in Figure 1, many of the tools contribute to more than one of these objectives.

A Behavioral Tool Kit

1. Provide Timely Feedback & Reminders

Research shows that timely feedback on energy consumption can help people adjust their behavior and give priority to making energy-efficient home improvements.[2] Yet, consumers have traditionally received only sporadic, delayed feedback on their home energy use. Further, such feedback generally aggregates the entire household's energy draw, leaving people unsure about the relative energy consumption of light bulbs, refrigerators, and clothes dryers.[3]

The effectiveness of feedback varies, depending on how and how frequently it is delivered and on whether it is combined with incentives.[4] It is clear, though, that real-time feedback is one of the most effective ways to promote energy conservation.[5] Devices that provide ongoing feedback on household or workplace energy consumption have consistently led to reductions in energy use within the range of 3% to 15%.[4–7]

Even less frequent or aggregated feedback can change behavior, however.[6] In one study, providing employees with monthly energy reports and energy reduction goals reduced building-wide energy consumption 7% more than was achieved by simple appeals to conserve.[8]

As is true of feedback, well-timed reminders to conserve energy and other resources can alter behavior significantly. Even established environmental programs, such as the 30-year-old Conservation Reserve Program, can benefit from them. This federal program pays rent to farmers who pledge to enact a set of conservation measures. The government boosted participation in the program and experienced a benefit–cost ratio of more than 20 to 1 by reminding people of the program's availability during the general sign-up period rather than before the period started.[9]

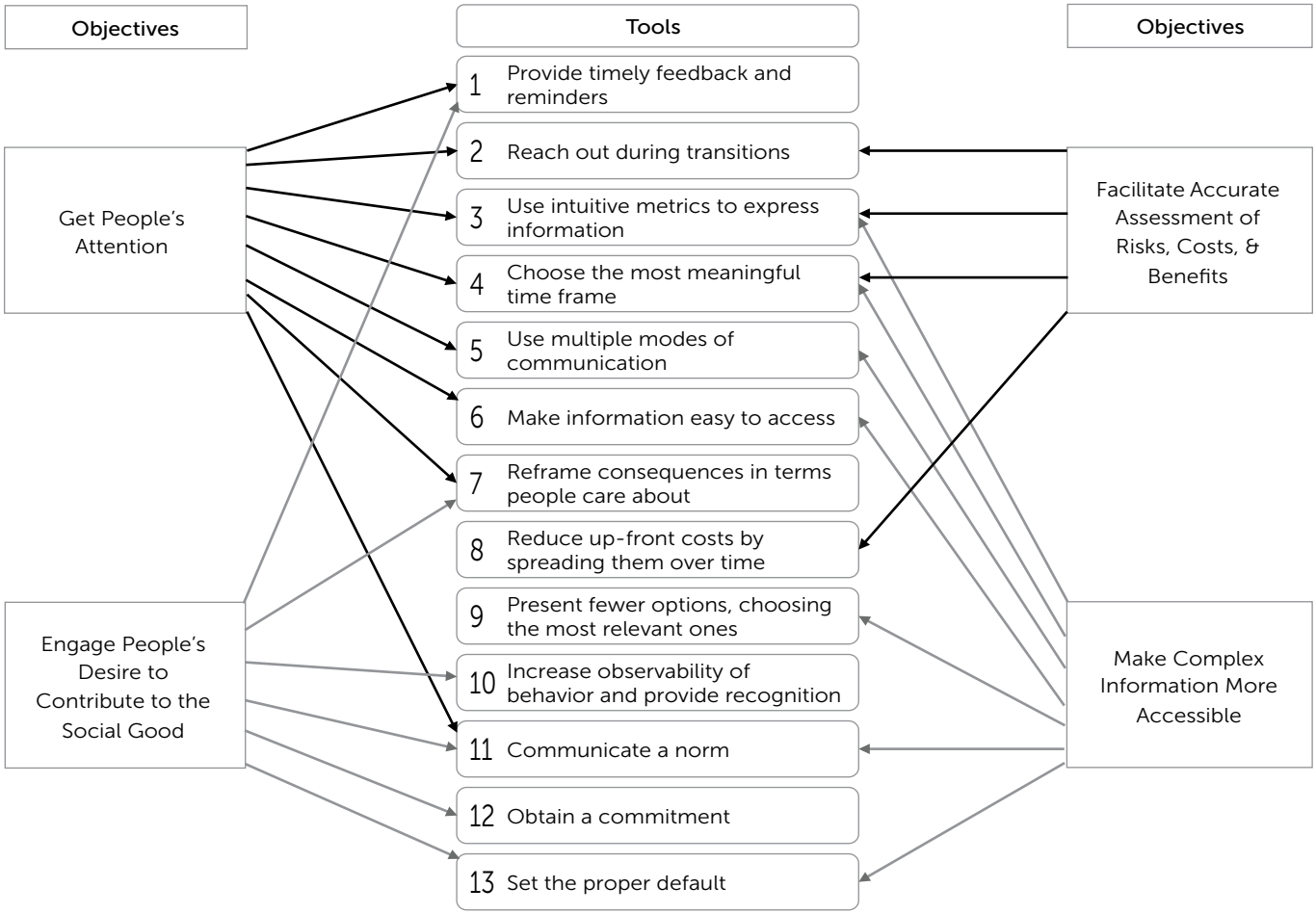
2. Reach Out During Transitions

People are busy and overloaded with information, and they can only pay attention to a limited number of appeals.[10] They are more likely to break habits[11,12] and are more responsive to opportunities to participate in energy-saving programs during home moves and other transitions in their lives, perhaps because they are already in the process of collecting new information.[13,14] The same is true when people are buying vehicles and major appliances. Information received during these periods can be crucial, because a single decision, such as which house, car, or appliance to buy, can have a large, persistent impact on energy use.[15]

Consider the following examples:

- Consumers are likely to achieve major and lasting energy savings if they replace a less energy-efficient appliance with a more

Figure 1. Several overarching objectives to be achieved by the 13 behavioral science tools described in this article



efficient one. Obtaining similarly large and persistent reductions through a repeated behavior change (for example, by turning off lights or changing thermostat settings) is more of a challenge.[15]

- Consumers reduce their vehicular emissions considerably more by buying a smaller or more fuel-efficient car than by changing their driving behavior (for example, by driving less or at a lower speed).[15]

- Homeowners may be more likely to obtain home energy audits if they are already getting a home inspection, say, at the time of a home purchase.

3. Use Intuitive Metrics to Express Information

Comparisons made on the basis of consumption metrics—such as gallons per 100 miles, SEER (seasonal energy efficiency ratio) ratings for air conditioners, or R-value (thermal resistance) ratings for insulation—can be clearer than those made using efficiency metrics, such as the familiar miles per gallon or kilowatt-hours. Efficiency metrics confuse consumers because they are not linearly related to the behavior in question, like driving less or buying a more efficient car. For instance, most people believe that switching from a vehicle that gets 20 miles per gallon (mpg) to one that gets 50 mpg will save more gas than going from 10 mpg to 20 mpg,

"Efficiency metrics confuse consumers because they are not linearly related to the behavior in question"

because the first improvement is larger both in absolute terms and as a percentage. However, the first trade-in saves 5 gallons every 100 miles, and the second trade-in saves only 3 gallons (as is revealed by flipping the equation and dividing the fixed distance, 100 miles, by miles per gallon). Consumption metrics, such as gallons per 100 miles, are commonly used in other countries and fix the misperceptions caused by miles-per-gallon ratings because they "do the right math" for consumers.[16] Gallons per 100 miles was added to the revised Environmental Protection Agency label for cars (the Monroney sticker) in 2013.

Another intuitive measure describes a household's consumption of energy and water relative to that of comparable neighbors, a practice used by such companies as Opower, WaterSmart, and Enertiv. This kind of comparison, which has other benefits that are discussed in the section on Tool 11 (relating to communicating norms), may be far easier for consumers to understand than technical metrics such as kilowatt-hours.

4. Choose the Most Meaningful Time Frame

When receiving energy or other resource use information, consumers respond well to placing the information in the context of expanded time frames that more meaningfully reflect the way people use a product.[17–19] For example, expressing gasoline costs over 100,000 miles of driving, rather than in terms of miles per gallon, increased people's preference for more efficient automobiles.[17] In fact, providing energy costs over a long time frame (such as 10 years) increases preferences for more efficient alternatives across a range of product categories.[18] Similarly, when presenting people with projected energy bill savings from a rooftop solar installation, it makes sense to highlight the estimated savings over the life of the panels rather than annual savings. Or, when presenting a local lender with the benefits of a community solar program, one can offer the expected reduction of default rates over the life of the loan rather than an annual rate.

Longer time horizons help improve decisions in other environmental domains, too. When selling flood insurance to a homeowner, for instance, the Federal Emergency Management Agency (FEMA) has found it effective to stretch the time horizon to make the likelihood of a future flood more salient. Rather than stating that there is a 1 in 100 chance that the house will experience a flood next year, FEMA notes that the chances of at least one flood during the next 25 years are greater than 1 in 5.[20] FEMA now tells homeowners that if they live in a 100-year floodplain, there is "a 1 in 4 chance of flooding during a 30-year mortgage."[21] The U.S. Corps of Engineers strengthened the effect of the expanded time horizon by comparing the probability of a flood with the likelihood of other disasters, observing that "during a 30-year mortgage period you are 27 times more likely to experience a flood than . . . a fire," and by making comparisons to other commonly experienced adverse events, such as being in a car accident.[22]

When companies provide insurance for environmental disasters, it makes sense to offer multiyear policies, because homeowners tend to cancel their policies after a short time if they have not had a loss. Keeping the premium constant over the length of the policy is also wise, because homeowners can budget more easily knowing that the premium will not go up. For example, offering 2-year hurricane insurance policies increased aggregate demand for disaster insurance compared with offering only 1-year policies.[23]

5. Use Multiple Modes of Communication

Consumers feel most comfortable making decisions when they receive information in their favorite mode (for example, verbal) and format (such as tables or information graphics). Risk information, however, is often communicated in numerical formats that require intimidating levels

of numeracy for some portions of the target audience. Using relative frequency information (for example, 1 in 100) rather than probabilities (for example, .01) can help people more accurately process risk information.[24,25]

Whenever possible, information should also be presented in a variety of ways to appeal to a broad audience and increase accessibility. Comprehension of information about climate-change uncertainty increases significantly, for instance, when the data are presented using both verbal and numerical descriptions—saying, for example, that a phenomenon is "likely" and also giving the odds (such as "greater than 66%")—rather than leaving out the numbers.[26,27]

6. Make Information Easy to Access

If people cannot access useful information easily, they are unlikely to act on it. Even if information is easily accessible but just seems hard to obtain, people may not bother trying to find it, or they may feel that they have an excuse to avoid trying to retrieve it. Something as simple as an e-mail with a direct link to the pertinent information can overcome these problems; people are more likely to look at and engage with an online energy information portal when they receive e-mails pointing to it.[28,29]

It is interesting to note that requiring that information be disclosed to consumers can lead firms to act in anticipation of that information's use by consumers. For example, in response to new rules making environmental disclosures mandatory, electric utilities changed their fuel mix.[30] Similarly, in response to calorie label mandates, fast food chains have increased the number of healthy menu options.[31]

7. Reframe Consequences in Terms People Care About

Reducing energy consumption is not an end in itself for most consumers. Thus, it is useful to translate energy use information into goals and objectives that people do care about. Unless they are explicitly told about a specific added benefit of an action, people may not realize that the action has implications for their health or budget,[32] and they might not think much about those implications when making a decision.[33]

"People pay disproportionate attention to immediate costs and too little to those in the future"

Consumers also can be motivated to contribute to a public good. For example, Swiss utility customers and U.S. respondents to an online survey were more likely to switch to a peak-hour added cost for electricity use if the decision was framed in terms of contributing to a public good rather than financial savings.[34] Telling people about the public health and environmental costs of electricity consumption is more effective than just reminding them of the financial costs.[5,35–36] Providing the same information in multiple formats allows users to focus on a consequence they care about; a case in point is the current Environmental Protection Agency vehicle label, which provides miles per gallon, gallons per 100 miles, average fuel costs per year, fuel costs relative to other vehicles, and anticipated greenhouse gas emissions.[32]

Framing actions as providing a public good is also expected to strengthen the effects of other interventions discussed below, such as Tools 10 and 11 (relating to increasing the observability of behaviors and communicating norms). However, such framing in the absence of other interventions can backfire,[37] perhaps because it raises doubts about the motives of the organization sending the message.

8. Reduce Up-Front Costs by Spreading Them Over Time

People pay disproportionate attention to immediate costs and too little to those in the future.[38] As a result, a high up-front cost for a program can be a deterrent, even if the program pays off in the long run. Consulting firms like McKinsey & Company have documented this phenomenon as a factor in the surprisingly low levels of investment in energy efficiency technologies.[39] One way to encourage individuals to invest in programs with high up-front costs is to provide

a long-term loan that spreads those costs over the life of the agreement. Homeowners might, for instance, decide to pay to elevate or flood-proof their house if the work lowers their flood insurance premium by so much that they end up saving money each year in spite of the loan payments. Similarly, Howard Kunreuther and Elke Weber proposed that more homeowners would invest in solar installations if they had no up-front costs but paid for a needed home-improvement loan with savings on electricity costs.[40]

the revised EPA gasoline consumption metric for cars is gallons per 100 mi.

3-15%

reductions in energy use from ongoing home or workplace feedback interventions

25%

chance of at least one flood in 100-year floodplain regions

Sometimes, even tiny up-front costs, such as effort and attention, can powerfully depress program uptake. Such costs can be eliminated or drastically reduced with a little foresight. For example, prepopulating fields on a sign-up or application form to reduce the applicant's paperwork could increase the uptake of beneficial programs. When H&R Block, a national tax preparation company, provided streamlined personal assistance for completing the eight-page, 100-question Free Application for Federal Student Aid (better known as FAFSA), the help resulted in increased student aid application rates and a 29% greater likelihood of the student attending college for 2 consecutive years.[41]

9. Present Fewer Options, Choosing the Most Relevant Ones

Sometimes when people are presented with many options, they get overwhelmed and decide against all of them or make suboptimal decisions.[42,43] Presenting fewer options by removing less effective ones from consideration not only simplifies the decision, it also helps the audience infer which option is most relevant to them, just as setting the right default does (Tool 13). For example, we recommend presenting homeowners with just the most relevant options when promoting flood insurance or offering financing for solar panels.

10. Increase Observability of Behavior & Provide Recognition

Making a person's contributions to the public good visible to others consistently increases the likelihood that the individual will decide to make altruistic choices.[44]

Consider the following examples:

- Participation in a *demand response* program—in which customers shift electricity usage away from peak periods in response to time-based rates or other forms of financial incentives—more than tripled when people joined the program via a public sign-up sheet in their community rather than anonymously.[37]
- Donations to a national park increased by 25% when a ranger asked guests for donations, rather than the park providing only an anonymous donation box.[45]
- Electricity consumption falls when people's rates of usage are made public.[46] Even telling people that they are part of a study reduces their consumption.[47]
- Industrial toxic emissions declined after corporate disclosure was required by the Emergency Planning and Community Right-to-Know Act of 1986.[48]
- Voting increased when Facebook offered badges for members to announce that they had done their civic duty.[49] In many contexts, like energy efficiency or environmental programs, the use of badges has the additional benefit of providing free advertising for a program when individuals share useful information or positive experiences within their social network.[50] User reviews may work similarly and have similar benefits.

Making socially desirable behavior visible probably increases such behavior in part because the display makes it easier for others to acknowledge the action and reward it in subsequent interactions. The effect is strongest when contributors to the social good highly value their relationship with the observers.[37]

11. Communicate a Norm

People are more likely to engage in a behavior, especially one that is costly to them but contributes to a social good, when told that this

behavior is the social norm.[44,51] Norms can be *injunctive*, describing what one ought to do,[52] or *descriptive*, announcing what others are doing. As a case in point, towel reuse increased 9% when, instead of just making a standard environmental appeal, such as "Help save the environment," hotels also informed guests that 75% of previous guests had reused their towels.[53] Likewise, energy and water conservation were increased by companies such as OPower, WaterSmart, and Enertiv when they let customers know how their household's consumption rate compared with that of their neighbors.[54–56] Of importance for environmental goals, such social comparisons can induce long-term behavioral changes (that is, changes that last more than 1 year).[57,58]

Conveying a norm is expected to have the greatest impact on behavior when people are unclear on what the norm is. Descriptive norms work particularly well when combined with injunctive norms.[52,56,59–62] Of course, it is not recommended to use a descriptive norm when the desired behavior is not already widespread or when the existing behavior is counterproductive. For example, signs at national parks should avoid implying that visitors regularly break the rules.[61]

Making deviations from norms readily observable (that is, combining Tools 10 and 11) allows norm followers to sanction norm violators. The social sanctioning of violators will increase as the share of followers grows, creating virtuous cycles.[63]

12. Obtain a Commitment

Asking people to commit to changing their behavior (for example, to reduce emissions), particularly in public (for example, by signing a public pledge), can increase the likelihood that they will engage in the desired behavior.[6,64] Even when not binding, public commitments can work, for many reasons. They make it easier to see whether people are contributing to the public good. They also help to establish a norm. Once others have committed, it is costly for an individual to shirk that behavior, because observers now know that the person was made aware of the opportunity to contribute and avoided it.

"set the default to be the option that most benefits the individual or the environment"

13. Set the Proper Default

When consumers have many choices, it is best, when possible, to set the default to be the option that most benefits the individual or the environment so that, by doing nothing, the consumer will end up with the most desirable option.[65] Defaults that benefit the environment (known as *green defaults*) enjoy widespread approval across the political spectrum in America.[66]

Strategies that make participation in a program the default and require potential participants to remove themselves if they do not like the default are known as *opt-out approaches*; they contrast with *opt-in strategies*, in which people must sign up if they want to participate. Possibilities for and examples of environmentally friendly opt-out strategies abound. Among them are the following:

- Public utility commissions could mandate that households be automatically enrolled in certain demand response or green power programs or require that new appliances be shipped with energy savings settings turned on by default. Such policies preserve all options for the individual but nudge consumers toward an individually or socially optimal decision.[67]

- A randomized, controlled trial conducted in Germany found that setting the default choice to automatic enrollment in a green power contract but allowing households to opt out resulted in a 10-fold increase in green power contracts.[68]

- To increase the number of home energy audits performed, policymakers could require that an energy audit and a Home Energy Score be provided whenever a home is purchased unless the home buyers opt out of the audit.

- A utility that allows consumers to choose the proportion of energy to be offset using renewable energy certificates (RECs)—purchases of power from renewable sources—could set the default to, say, a state's REC target of 15%, rather than 0%.

- An infrastructure rating system called ENVISION that allows engineers and architects to earn certificates for energy-efficient and otherwise sustainable design decisions raised the default in its software from current industry practice to the second most ambitious design level. The sustainability index of designs created with the software increased by 24%.[69]

Defaults work for several reasons. They can establish a norm, are often interpreted as implicit endorsements, and simplify decisions. A caveat: Consumers sometimes perceive the default as reducing their freedom to choose. Asking individuals if they would like to be assigned to the default option can help reduce negative reactions to the default without any reduction in the effectiveness of the default condition.[70]

Moving Forward

This collection of practical, cost-effective tools can boost energy and environmental conservation, serving as a useful complement or alternative to taxes, subsidies, and cap-and-trade or command-and-control regulations. We encourage policymakers and business leaders who wish to explore these ideas to contact us at appliedcooperationteam@gmail.com.

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report

Overcoming behavioral obstacles to escaping poverty

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abstract

International development policy is ripe for an overhaul. Behavioral science can help policymakers to spur changes in behaviors that are difficult to explain from a conventional economic perspective and impede economic development. We focus here on two well-documented, often coinciding psychological phenomena that have particularly wide-ranging implications for development policy: present bias (favoring immediate rewards over long-term considerations) and limited attention. We present a number of general policy recommendations that are informed by insight into these phenomena and offer concrete examples of how the recommendations can be implemented to help low-income individuals improve their lives and reach their long-term goals.

Bryan, C. J., Mazar, N., Jamison, J., Braithwaite, J., Dechausay, N., Fishbane, A., . . . Vakis, R. (2017). Overcoming behavioral obstacles to escaping poverty. *Behavioral Science & Policy, 3*(1), 81–91.

Core Findings

What is the issue?
International development policy should take human psychological phenomena into account as well as classic economic theory. In particular, research shows that individuals exhibit irrational biases toward the present, and poverty limits their attention spans. Developing interventions that account for these phenomena can boost uptake and effectiveness.

How can you act?
Selected recommendations include:
1) Timing the delivery of interventions for when people are most likely to be receptive, such as after a harvest
2) Offering programs that lock in or otherwise increase commitment to savings
3) Using cognitive aids to remind people of optimal behavior

Who should take the lead?
Behavioral science researchers, policymakers in development

How can international development policies induce farmers to adopt improved agricultural technologies, get parents to vaccinate their children, prompt patients to comply with treatment regimens, and encourage poor people to save more? These seemingly disparate challenges have a common feature: insights from behavioral science can help to improve the effectiveness of efforts to address them.

For example, the standard rational perspective of classic economic theory would predict that offering a higher interest rate should motivate people to save more. A recent field experiment in Chile found, however, that a large majority of participants did not increase savings in response to this approach, even though interest rates increased substantially, from 0.3% to 5%. By contrast, savings almost doubled when subjects were able to announce their savings goals to a self-help group and had their progress publicly monitored and rewarded in nonmonetary ways—such as with praise—at the group's weekly meetings.[1] Thus, a basic understanding of even a small number of the principles that guide human behavior can help policymakers to alter behaviors that make little sense from a conventional economic perspective and pose challenges to economic development.

We discuss two well-studied psychological phenomena that have wide-ranging implications for international development policy: present bias and limited attention. For clarity, we begin by explaining the two concepts separately, although they operate concurrently in many of the situations we discuss.

Present Bias Deters Investment in the Future

Investing in the future is critical to people's well-being. Such investments can take many forms, such as saving to buy business supplies without paying exorbitant interest rates to a moneylender, purchasing fertilizer to improve next year's crop yield, sending children to school, or traveling to get preventative medical care. These examples might sound like obvious steps to take, but behavioral science reveals that people often fail to expend small amounts of money, time, or effort up front to obtain much larger benefits in the future. When it comes to trading off between immediate and future outcomes, such decisions depend on the relative weight one assigns to results achieved now versus later on. The pull of instant gratification often keeps people from making the optimal choices they say they would have made if someone had asked them to reflect on those decisions when not under the immediate influence of temptation. In other words, present bias—overweighting short-term versus long-term rewards—gets in the way.[2]

This deviation from optimality occurs frequently. In the abstract, people often prefer to make the long-run investment but then are tempted in the moment to take the immediate benefit, only to regret the choice later.[3] For example, a parent who knows she should be saving for her child's school fees might falter and purchase a tempting meal if she walks past a restaurant when she is hungry. Conversely, a small but unpleasant obstacle right now can have a large influence on decisions: a parent might want to vaccinate her child, but the prospect of a long, hot walk to the clinic (when she doesn't know for sure that the clinic will even be open) might lead her to procrastinate—perhaps indefinitely.

Present bias is common to those in rich and poor countries alike.[2] Behavioral scientists have not only documented the phenomenon but have also worked with international development experts and policymakers to design programs that take it into account. Many of these programs have been rigorously tested and proved to be effective at changing behavior in ways that lead to positive long-run outcomes.

Limited Attention Impairs Decisionmaking

To understand poverty, one must recognize that its defining features—the shortage of money, time, and basic necessities such as sleep and food—affect psychological functioning in nonobvious ways that can undermine poor people's ability to escape their circumstances. This is true even when policies or programs are implemented that, in principle, provide sufficient

opportunities for people to pull themselves out of poverty. Everyone has limited attentional bandwidth, but wealthy people, freed from having to spend this precious attention on acquiring food, shelter, and other basics, have more attention available for handling unexpected hassles and making strategic decisions to improve their circumstances. In contrast, the challenge of navigating everyday life when one lacks adequate resources is enormous. Poor people are often left with little or no spare attentional capacity to devote to such important things as remembering to take their pills every day or navigating the complicated bureaucratic process to qualify for an assistance program. Making matters worse, poverty directly affects the environment in which people live, which often creates additional attentional demands. For example, lack of access to such basic services as piped water, electricity, child care, and affordable financial services adds numerous daily decisions to the cognitive plate of a person in poverty, whose attentional bandwidth is already scarce.[4,5]

Principles for Policymakers

In general, policies aimed at serving the poor will be more effective if they alleviate the difficulties imposed by present bias and limited attention. Although both conditions are pervasive across humanity, they take a greater toll on the well-being of those experiencing scarcity than on the well-being of those who are wealthier. Next, we discuss several policy strategies that can achieve this goal and provide evidence of their effectiveness in a range of sectors.

Reduce the Up-Front Cost of Future-Oriented Behavior

Everyone has some tendency to procrastinate; people delay doing what they know is in their long-term interest because they usually have no compelling reason to bear the up-front cost today when they can put it off until tomorrow. The narrowing of attention produced by poverty—focusing on immediately pressing needs to the exclusion of other important but less urgent needs[5]—aggravates this natural present bias. As a result, even minor up-front costs, such as small copayments, minor inconveniences, or the need to expend extra effort, can be important barriers to investment in future well-being.

A key practical policy lesson that flows from this understanding is that the way to battle procrastination in well-being investments is to reduce and ideally abolish the up-front cost of obtaining health products that offer substantial benefits at reasonable prices but go underutilized. Fifteen randomized trials showed dramatic increases in uptake in response to even small reductions in prices for products such as insecticide-treated bed nets (ITNs) for avoiding mosquito-borne diseases, dilute chlorine for disinfecting drinking water, and deworming tablets.[6] This principle helped catalyze large-scale distribution of free ITNs in sub-Saharan Africa, an effort that is estimated to have saved 4 million lives since 2000.[7] Similar actions could produce cost effective increases in the use of many other prophylactic products that can increase the well-being of people living in the developing world.

Likewise, reducing the up-front costs associated with education could yield outsized benefits. One study illustrating this point found that providing free school uniforms to students in Kenya at a cost to the state of $6 a student, a small fraction of the total cost of a child's education, led to a 6.4 percentage point increase in school attendance.[8] Helping countries reduce or eliminate school fees and giving vouchers for free school uniforms are practical and straightforward policies that could improve school enrollment in places where it is low.

Beyond reducing fees for long-term investments, minimizing or eliminating what might seem like trivial inconveniences can dramatically increase the uptake of services. This approach could include strategies such as reducing or simplifying paperwork (or better yet, instituting automatic enrollment in programs), minimizing travel times required to take advantage of programs, and helping with child care and transportation. In one instance, helping households to fill out the application for an interest-free loan to cover the cost of piped water in Morocco increased participation from 10% to 69%.[9] (This jump mirrors the U.S. finding that helping families fill in FAFSA forms for federal student aid increased

4m

lives saved in sub-Saharan Africa from insecticide-treated bed net interventions, since 2000

the cost of a school uniform intervention in Kenya associated with a 6.4 percentage point increase in attendance is **$6 per student**

33%

increase in immunization rates in rural Rajasthan associated with the provision of free lentils at clinics

"It can sometimes be better to charge a small fee and make a service very convenient than to charge nothing for a very inconvenient service"

low-income students' first-year college attendance rate by 24%.)[10]

The need to travel even modest distances (that is, more than a 10- to 15-minute walk) is another type of inconvenience that can powerfully dampen service uptake. In Malawi, the likelihood that people would show up to receive the results of an HIV test fell sharply when the distance they needed to travel increased by even a small amount.[11] Similarly, in Kenya, the likelihood that people would take advantage of protected springs as a water source that reduced the risk of diarrhea fell with small increases in the distance they had to travel to reach the water.[12]

Because price and inconvenience are both barriers to investing in future well-being, policymakers should think carefully about the trade-offs between them. One might assume that the poor would be willing to endure significant inconvenience to avoid even a small financial cost for services, but this assumption has a serious flaw: it fails to appreciate that overcoming inconvenience requires attention (to plan for and solve logistical challenges) that poor people cannot spare. Therefore, it can sometimes be better to charge a small fee and make a service very convenient than to charge nothing for a very inconvenient service.

This point is illustrated by the success of a nonprofit entrepreneurial program for delivering preventive health products in rural Uganda. A randomized evaluation found impressive community health gains when women sold underused health products such as ITNs, water purification tablets, and antimalarial drugs door to door at a discounted (but nontrivial) price, eliminating the hassle of seeking these products out.[13]

Charging a bit to reduce inconvenience is a very promising approach that deserves to be scaled up. Notably, it could be expanded to improve maternal and child health broadly, because travel is particularly difficult for pregnant women and those with young infants. Ideally, all pregnant women would undergo at least one prenatal checkup (so a medical professional can assess risk factors and encourage the mother to have a trained attendant at the birth) and all infants would receive basic immunizations. Evidence suggests that use of such services would increase dramatically if they were provided within villages or at least at coordinated central locations accessible by cheap and easy transportation and if other forms of assistance were available (for example, a teen helper coming to the woman's door to accompany her or watch her other children while she went for a checkup). Conversely, in situations where logistical constraints require that services be provided at less convenient locations, small (but immediate) material incentives (for example, a bag of lentils and a set of metal plates) can be an effective way to offset inconvenience. In India, free lentils increased immunization rates in rural Rajasthan from 6% to 39%.[14]

Time the Delivery of Subsidies for When People Are Most Likely to Be Receptive

Both present bias and limited attention suggest that the timing of interventions can be critically important in ways that are not obvious from a traditional economic perspective. For example, sugarcane farmers in India typically receive their income once a year—at the time of harvest—and therefore tend to be relatively rich right after the harvest and relatively poor right before it. In a powerful illustration of both the attentional costs of poverty and the importance of timing, a recent study documented that these farmers perform worse on tests of sustained attention in the period immediately before the harvest, when money is tight. The difference in scores translates to roughly 10 IQ points.[15]

Traditionally, the timing of subsidies has been determined arbitrarily, presumably on the assumption that a subsidy delivered now is

"At times, people will take elaborate steps to protect themselves from succumbing to short-term temptations"

at least as useful as a subsidy delivered later. But recent evidence from behavioral science and development research indicates that this approach misses an opportunity to enhance uptake: it would be more effective to give subsidies at times when people are most likely to have the attentional bandwidth needed to think about and take full advantage of them. It seems probable, for instance, that the low-income sugarcane farmers would be in a better mental state to evaluate and accept a beneficial offer immediately after the harvest, when they face fewer pressing demands.

Aligning the timing of subsidies with the timing of important decisions or expenses is another effective strategy. In Tanzania, promoters of health insurance deliberately went to the distribution points of a cash transfer program to sign people up for health insurance when they received the transfers (and therefore had greater liquidity). This deliberate timing contributed to a 20 percentage point increase in the use of health insurance.[16] Similarly, farmers respond more favorably to the promotion of agricultural products (such as fertilizer and hybrid seeds) if approached at harvest time, when they have money available for those investments and when their attentional capacity is not overly taxed by the need to grapple with scarce financial resources. Finally, subsidies to encourage education could be timed to coincide with when school fees are due. In a recent demonstration of the value of this approach, a program in Bogota, Columbia, that offered cash conditionally in exchange for reenrolling children in school produced higher rates of reenrollment when a portion of the monthly transfer was postponed until just before the reenrollment period. Moreover, this time-sensitive design was particularly effective for those who needed it the most (and whose families were most likely to be facing scarce liquidity and attention): the students from the families with the lowest incomes and the lowest participation rates.[17] To maximize effectiveness, such programs should give parents advance notice of the subsidy and possibly even help with planning and budgeting, to ensure that they have money available to pay for expenses beyond those covered by the subsidy.

Offer Programs That Lock In or Otherwise Increase Commitments to Savings

People are often well aware that temptation or distraction at critical moments can derail their pursuit of long-term goals. As a result, to keep themselves on track, they may be willing—even eager—to subject themselves to costly penalties for failing to stick to their goals.[18] African farmers living in poverty offer an example of how such *commitment savings* approaches can be made to work. Impoverished farmers sometimes underuse technologies that they say they want and know can increase profits. This is probably partly because they get paid at harvest but do not need hybrid seed and fertilizer until months later; holding on to their money that long can be hard. Offering a small, time-limited discount on the cost of acquiring fertilizer (for example, in the form of free delivery) right after harvest, when money is relatively plentiful, is a form of commitment savings that has been found to increase purchase rates of fertilizers in Kenya by 11 percentage points.[19] Estimates suggest that to produce a similar purchase rate later on, when fertilizer would normally be bought, a 50% subsidy of the purchase price would be needed.

At times, people will take elaborate steps to protect themselves from succumbing to short-term temptations.[20,21] They may choose, for instance, to lock their money away where they cannot access it for some predetermined length of time.[22,23] Some people may even pay for this restriction on their freedom, for example, by accepting a lower interest rate on money they cannot easily access on a whim.

One concern with commitment devices is that they come with a risk: Locking money away means it is not available for unanticipated but genuinely important expenses. This worry

can prevent people from taking advantage of commitment devices or can constrain people's ability to cope if they do commit and then an urgent situation arises. An alternative, inspired by work on the theory of mental accounting, is soft commitments, such as labeling a savings account for particular expenditures (like education) without a strict constraint on how the money in it can actually be spent.[24] In a recent study in Uganda, researchers compared a program in which saved money could only be used for educational expenses with a program in which the savings were encouraged but not required to go to education (that is, it was possible to simply withdraw the cash). In both cases, families saved more and spent more on education supplies than a control group did. But families saved the most money in the latter case, when they knew they could still withdraw the money for other things if they needed to.[25]

Thus, making commitment devices available (and easy to use) can be an effective tool—and one that is even sought out by individuals who recognize their susceptibility to short-term temptation, poor planning, and distraction—especially at times of peak demand on people's limited attentional resources. These tools are, however, not useful for all individuals, and softer commitments, such as earmarking an account for particular expenses, may be preferable in situations when more flexibility is required.

Introduce Cognitive Aids

Because poor people often have to attend to multiple pressing needs at the same time, the limits of their attention are continually strained.[5] Thus, it is not surprising that they may be more likely than others to miss crucial information or forget to take intended actions that could improve their welfare. Sometimes, statements explicitly pointing out what might seem obvious to a person not suffering from attentional scarcity can make a big difference. In a recent study, experienced seaweed farmers in Indonesia had noticed that the spacing between their seaweed strands affected their yield, so they paid attention to the spacing when planting the strands. But the farmers failed to notice that the size of the strands they planted also affected their yield, even though the lower yield was easily observable. Consequently, they did not consider strand size in farming decisions and did not even know what the size of the strands they used was. The study showed that merely offering farmers the opportunity to observe how researchers varied the size of the strands and the effect of that variable on yield was not enough for farmers to notice the relationship. Only when researchers explicitly pointed out the relationship between strand size and yield did farmers notice it and change their practices.[26] This result has nothing to do with the intelligence of the farmers. A fact is only obvious if the observer has the spare attentional capacity to notice it.[27]

Simple reminders are another type of straightforward cognitive aid that can be surprisingly beneficial. All people sometimes forget to do things they meant to do—take pills, mail the rent check, and so on. But, perhaps unsurprisingly, when attention is overtaxed, people are even less likely to follow through with intended actions. When attention is completely taken up with pressing demands, people are unlikely to step back and ask whether they are forgetting to do something. A policy problem that exemplifies the worsened *intention–action gap* that occurs when bandwidth is constrained is the incomplete adherence to medical treatment regimens for conditions like tuberculosis or HIV/AIDS. In the case of HIV, patients commonly receive a 1-month supply of pills and must remember to take those pills every day. Even when patients understand and genuinely intend to adhere to their treatment, they often forget to do so amid the chaos of other pressing demands on their attention. The consequences of such forgetting can be life-threatening, but a simple fix can help. For example, research in rural Kenya demonstrated that the percentage of HIV patients who achieved perfect or near-perfect treatment adherence (that is, at least 90%) during the nearly yearlong study period increased from 40% to 53% when they received weekly text-message reminders.[28]

Similarly, although breastfeeding is considered the best practice for nourishing babies (especially because high-quality infant formula and clean water are not available in much of the developing world), competing responsibilities—such

as household chores or caring for older children—can make keeping it up difficult. Simple cognitive aids can help, including, for example, physical reminders, such as stickers on bottles, that note that bottles are appropriate primarily for older infants and toddlers.

Sometimes aids that might seem unnecessary to a person whose attention is not overburdened can be enormously helpful to someone whose attention is overwhelmed. Simple actions, like pointing out well-known facts at the right time or sending well-timed reminders, can be important tools to improve decisionmaking among the poor. Reminder messages in particular have been delivered in field experiments by text message, e-mail, postcard, letter, phone, and in-person survey. They have been shown to improve a wide range of outcomes, including saving rates in Uganda;[25] loan repayment in Bolivia, Peru, and the Philippines;[29,30] compliance with obligatory child support payments in the United States;[31] vaccination rates in rural Guatemala;[32] use of water treatment products in Kenya;[33,34] and payment of delinquent fines in the United Kingdom.[35] But reminders must not be too frequent or they risk crossing the line from useful aid to additional drain on limited attention.[28] Also, they are likely to be especially effective for irregular events, such as immunization visits, for which people are less able to form a habit.

A Need for Experimentation

A couple of issues relating to these strategies merit consideration. When tested, certain minor variations often work better than others—sometimes in ways and for reasons that would have been difficult to anticipate without testing. This not only suggests the need for more experimentation but also underscores the sometimes surprising impact of subtle design features. For example, not all reminders are equally effective. Although weekly messages worked very well for HIV treatment adherence in rural Kenya, an alternative design with daily messages did not affect adherence (presumably because too-frequent messages are ignored—or, worse, become an added cognitive burden).[28] Additional research is needed to provide generalizable rules of thumb for design issues such as timing, length, and frequency of reminders; mode of delivery; content; and framing of messages. But even with more research, general rules can offer only limited guidance about the optimal implementation of a policy. It is often difficult to predict how cultural differences and unobserved variation between contexts might influence the effect of even a well-researched treatment. Thus, wherever feasible, any new policy applying behavioral principles should be evaluated rigorously in the context in which it is meant to be implemented before being deployed at scale (as should all new policies).

"opportunities exist to layer behavioral interventions on top of existing programs"

A second issue is that although many findings demonstrate that the strategies listed here have had significant effects in the short run, little is known about how long the effects last. This uncertainty is immaterial in situations where the goal is to encourage one-off actions, such as when sending a one-time reminder to get children vaccinated. It is more of a concern when the effectiveness of a policy or program depends on people taking sustained, repeated action to form a new habit, as is the case when daily reminders are sent with the intention of increasing compliance with long-term medical regimens. Further research is needed to clarify the long-term effects of some of these techniques.

Policymakers are in an ideal position to conduct much of this research. They are often mandated to implement specific programs in particular settings and populations, which seems to leave little room for experimentation of the type described above. But because many of these interventions are inexpensive or free to implement, opportunities exist to layer behavioral interventions on top of existing programs. For instance, automated reminder text messages can be sent in bulk at extremely low cost. Therefore, an existing program to promote vaccination

Sample behavioral strategies to enhance the effectiveness of development programs and policies

Recommended policy strategy	Psychological phenomenon behind recommendation	Sample policies
Reduce the up-front cost of future-oriented behavior	Present bias and limited attention	• Reduce or abolish copayments for underutilized preventive health products such as insecticide-treated bed nets, hand soap, or family planning products.[A] • Reduce logistical hurdles and, where relevant, the potential embarrassment associated with the uptake of preventive health and family planning products by organizing entrepreneurs to sell such products (at discounted prices) door to door, increasing convenience and privacy.[B] • Reduce bureaucratic hurdles to program uptake through automatic enrollment or simplified paperwork.[C] • Reduce travel times to take advantage of programs such as prenatal health care, either by providing such services within villages or by organizing easy, low-cost transportation to central locations.[D]
Time subsidies for when people are most likely to be receptive, such as when they are making important decisions or outlays	Present bias and limited attention	• Offer beneficial but high-cost products or services (for example, health insurance) at times when people have greater liquidity (for example, right after a cash transfer) and more spare attentional capacity to evaluate offers.[E] • Align the timing of cash transfers with the time at which school fees are due to encourage school enrollment.[F]
Offer programs that that lock in or otherwise facilitate savings	Present bias and limited attention	• Incentivize the purchase of farming technologies (for example, fertilizer, hybrid seed) immediately after the harvest, alleviating the need for farmers to save money from the harvest until the next year's planting season.[G] • When the inflexibility of hard commitments discourages participation or risks imposing undue costs on people, offer soft commitments, such as savings programs that are earmarked for specific expenses (for example, education) but still allow the savings to be used for other purposes.[H,I]
Introduce cognitive aids	Limited attention	• Provide text, e-mail, postcard, letter, or phone reminders of the need for important actions, such as taking HIV medication, contributing to savings accounts, or using water treatment products.[F,J–L]

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(such as a vaccination camp) could easily and cheaply send text reminders to a randomly chosen subset of the target population and then compare the vaccination rates in the groups that did and did not receive the reminders.

Other messaging interventions can be added to existing programs in similarly straightforward ways, especially when the program already includes communication with potential recipients. For instance, it is trivial to add a request for a soft commitment to an existing interaction with the recipient. Similarly, tests of optimal intervention timing can often be conducted without additional cost if programs are rolled out over a period of time. If, say, fertilizer discounts are already being made available to farmers, policymakers might be in a position to vary the timing at which these discounts are announced in randomly selected areas and thereby learn about the differential impact of the program as a function of offer timing. (This approach is a specific example of a more general method, called *phase-in design,* for achieving randomization even when programs are to be delivered to every household or individual in a particular area.) Such piggybacking of behavioral intervention tests on existing programs would allow even policymakers with strong and inflexible implementation mandates to discover techniques that could improve the effectiveness of the programs they already have in place.

Policymakers need to experiment, but they also need to be aware of their own biases. Like other humans, they have limited attentional bandwidth and often devote too little thought to decisions because they think they already know the answer or because their own cultural, political, or moral perspective constrains their thinking in ways they might not even notice. Indeed, even technically trained professionals at the World Bank recently were shown to make more mistakes when evaluating data that were presented as referring to a controversial topic in their field than they did when the same data were framed as referring to a neutral topic.[36] Relatedly, personal predispositions might lead some policymakers to presume that behavioral interventions are ineffective and others to see those same interventions as "silver bullet" solutions for all problems. The truth lies somewhere in between and is considerably more nuanced. Nevertheless, it is now clear that behavioral interventions are a valuable tool, and when such interventions are combined with more conventional policy tools—such as regulation, education and training, standard economic incentives, and infrastructure—they can help ameliorate poverty and improve well-being.

The Long View

Living in poverty puts additional and often overwhelming demands on a person's attention. This attentional burden can intensify present bias and otherwise impair decisionmaking, causing the poor to miss opportunities to improve their situation. Behavioral insights suggest techniques to lessen the negative impact of this attentional tax on the poor. These techniques often complement more traditional approaches to easing the burdens of the poor. Applications of the principles outlined here offer tremendous promise for improving the effectiveness of development programs.

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report

Increasing benefits & reducing social costs of technological innovations

Andrew Van de Ven, Ron Adner, Stephen Barley, Deborah Dougherty, Jane Fountain, Andrew Hargadon, Mark Kamlet, Beth Karlin, & Melissa Schilling

abstract

Technological innovation is a double-edged sword. It can help solve major problems, such as how to treat cancer, and can be an engine of economic growth, but it can also cost jobs, such as when automation replaces people. Both aspects raise issues that have major but so far little-recognized policy implications. One such issue is that new technologies are now taking the place not just of routinized jobs but of more complex positions. Another is that many government policies meant to foster needed innovation are based on an outmoded understanding of how innovation occurs and thus are not as effective as they could be. As behavioral scientists who study technology and innovation, we offer insights into addressing both issues.

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Core Findings

What is the issue?
Technological innovations, like artificial intelligence (AI) or vastly more powerful computer chips, are automating production control systems. While this is yielding significant benefits for society, governments must manage this innovation to provide safety nets for labor replaced by automation. The innovation process itself is not linear, and innovation policy should be designed accordingly.

How can you act?
Selected recommendations include: 1) Revising policies that unduly constrain the recombination of extant knowledge and technology for new applications 2) Emphasizing procedures and incentives that allow technologies to be put to new uses over time

Who should take the lead?
Behavioral science researchers, policymakers in technology, science, innovation

Technological innovations—especially in the ways people communicate with one another and exploit data—are profoundly affecting society in positive and negative ways. They have resulted in the creation of the ever-changing Internet and advances in medicine, and they are fueling the rise of new businesses and new kinds of jobs. Yet they are also costing jobs in many fields. In this article, we focus on the need to minimize the downsides of technological innovation while enhancing the development and adoption of the radical advances that benefit society. In particular, we examine two issues that have not received much public notice but have major policy implications.

First, computers are now able to take the place not just of workers who perform routine tasks but of people who handle more complex responsibilities, such as recognizing patterns in data from business logistics, retail sales and services, and even radiology. In addition, information technologies increasingly permit work that was previously performed by individuals in full-time jobs to be done by independent contractors who receive no health care, unemployment, disability, or pension benefits. As employment across a wide range of occupations becomes more uncertain, many people will have to change jobs more often over the span of their careers than has been true in the past. What should be done with an excess labor force that is made up of highly skilled workers who are unlikely to find jobs providing the income they had before? And how can a safety net be provided for Americans whose health insurance or retirement accounts may not be portable from job to job?

Second, given that technological innovation remains important for the health of the economy and other realms, the federal government should foster it as effectively as it can. Studies show, however, that the processes that encourage the development and adoption of game-changing innovations are more complex than the people creating government policies and practices consider. Innovations do not follow a simple set of stages that begins with research and ends with small-scale testing and large-scale commercialization. Instead, the process typically involves nonlinear interactions and feedback at all stages of technology development, as well as across different streams of people working cooperatively or competitively on their own aspects of the technology, from the science of the initial concept to the marketing of the final product. This realization has several important implications for how government agencies should manage the processes involved in innovation.

So far, the problems of displaced high-level workers defy easy resolutions. But behavioral science does suggest broad policy recommendations that should enhance the government's ability to nourish useful technological innovation.

Technology's New Effects on the Workforce

In 1965, William Faunce argued that all production systems consist of four components: a power system, a system for transforming raw materials, a transfer system for moving objects in space, and a control system that coordinated the other three. He claimed that the first industrial revolution automated power sources, while the second brought automation to systems for transforming and transferring materials and goods. He also predicted that computers would automate control systems. Today, society is well along the path that Faunce forecasted.[1] Many key innovations in the last 15 years—particularly those enabled by artificial intelligence (computer software that learns from experience and can make predictions based on patterns in complex data) and vastly cheaper, more powerful chips—have indeed made automated control possible in manufacturing[2] as well as in service industries.

At one time, the introduction of new technologies created jobs for people who managed their use. But the opposite is often true now: technological innovations pull humans out of control positions and replace them with intelligent machines,[3,4] leaving skilled workers with fewer options for earning a reasonable income.

Several well-known examples illustrate how the trends that Faunce predicted[1] have come

to pass. Through the online retailer Amazon, consumers can now easily order and pay for goods via sophisticated computational devices that can be activated from nearly any computer or smartphone. Once Amazon's computers receive the order, they instruct robots to retrieve the ordered goods from shelving in a warehouse, which then move those goods to a mailing station, where a human touches the items for the first time—picking them up off the cart and sending them to other machines to prepare for shipping.[5] The smart grid is another example. Embedding microprocessors in the electrical grid allows utilities to automatically monitor electricity use, alter the amount of electricity flowing from one point to another, and charge a variety of rates for electricity depending on when the electricity of consumed—all without the intervention of meter readers and other workers. Self-driving cars are yet another case in point. They depend on sensors and microelectronic controls to replace the control previously exerted by human drivers. Vehicle manufacturers have begun to experiment with self-driving trucks,[6] which threaten the livelihood of truck drivers. In 31 of America's 50 states, the most common form of employment is as a truck, delivery, or tractor-trailer driver.[7]

Although it is difficult to predict how many people and which jobs are likely to be affected by advanced control technologies, recent studies provide some estimates. Frey and Osborne combined information on what various forms of artificial intelligence are currently capable of doing with data on the skills involved in 702 occupations (drawn from O*Net) to estimate the percentage of jobs that would be affected by computerized control technologies.[8] The occupations they examined ranged from the most cognitively complex to the most manually intensive. Their estimates suggested that 47% of U.S. employment would be at risk over the next two decades.[8] The occupational categories most at risk, according to Frey and Osborne's analysis, are service, sales, office and administrative support, production, transportation, and materials handling.[8] Frey and Osborne's analysis indicated that automation based on machine learning will render obsolete additional jobs with midlevel wages and thereby further exacerbate income inequality.

"it is unclear what percentage of the labor force is actually capable of learning high-level STEM skills"

Few Good Solutions

Many observers have emphasized the need to train more people in STEM (science, technology, engineering, and mathematics) fields, both to provide alternative forms of employment and to enhance desired kinds of innovation.[9] This approach to employment policy has several flaws, however. First, it appears that many programs designed to make people more employable in a postindustrial economy focus less on technical skills and more on basic social skills needed to land a job, such as writing résumés and interviewing well.[10,11] Second, it is unclear what percentage of the labor force is actually capable of learning high-level STEM skills. The emphasis on high-level skills is crucial because mounting evidence indicates that advances in artificial intelligence will soon make it possible for computers to make inferences currently performed by humans who do fairly sophisticated STEM work.[12–14] Witness, for example, recent research indicating that pattern-recognition software and intelligent machines do a higher quality and less costly job than human radiologists do in interpreting scans taken to diagnose certain disorders.[15,16]

Given that jobs may continue to be scarce or to convert from full time to freelance, the U.S. Government Accountability Office and others have called for decoupling the American social safety net from specific employers so that people can take their health insurance or retirement accounts with them from job to job.[17,18] So far, however, progress in that direction has been slow.

Improving Innovation

Government Participation Is Critical

At the moment, prospects for enhancing the benefits of technological innovation are much brighter than for minimizing the social harms it unleashes. For policymakers, a key question is: What should be the government's role in facilitating innovation, including developing and operating the *innovation infrastructure*—the collection of systems and entities that incubate the creation of radically new products, procedures, and services and facilitate their commercial success?[19]

There is no question that government has to be involved. Many studies have found that government plays a critical role in building innovation infrastructures (also known as *ecosystems*), because the private sector alone does not have the required resources, legitimacy, capabilities, or market incentives to do so.[20–22] But the government cannot perform the job alone; joint public–private collaboration is required to build a successful innovation infrastructure.[23,24] This infrastructure includes (a) institutional arrangements that regulate, set standards for, and legitimize a new technology; (b) mechanisms for public funding of basic scientific research and knowledge bases and for the education and training of workers; (c) systems for developing markets, educating consumers, and generating demand; and (d) private businesses that conduct proprietary research and carry out product development, manufacturing, and distribution with the aim of making a profit.

Many studies have found, for instance, that commercialization of a technological innovation is a collective result of many actors in public- and private-sector organizations who engage in developing these complementary infrastructure components over extended periods of time.[20,25–28] Some actions are helpful; others are not. For example, government regulations and costly and slow review and approval processes can constrain innovation, as businesspeople in various industries complain,[29] but government funding of basic research enables technological innovations. Studies of biotechnologies[30] and cochlear implants[24] document that government-funded basic research in universities and government laboratories predated by 20 to 40 years the proprietary appropriation of this public knowledge for commercial development.

Programmatic government funding and investment have also been critical in building innovation infrastructures that support the development of more traditional, physical infrastructures—such as the interstate highway system, built in the 1950s and early 1960s, and hydroelectric power systems, built in the 1930s. Both of these systems were part of the New Deal's attempt to eliminate mass unemployment. Today, again, major infrastructure projects carried out by the private sector with government contracts seem to be an attractive way to promote innovation and put people to work in jobs at multiple levels.

Policies That Encourage Innovation

Behavioral science suggests a need to reexamine the process by which innovations and the infrastructures that support them develop. In 1944, President Roosevelt asked his science advisor, Vannevar Bush, how wartime investments in science might contribute to peacetime society. In response, Bush's 1945 report, *Science: The Endless Frontier,* laid out the government's first formal innovation policy, outlining a bold new vision of how federally funded basic research could and would solve the nation's—and the world's—problems of disease, hunger, poverty, and national security.[31]

Besides specifying the federal government's role in supporting innovation, Bush defined the innovation process itself—creating a language that still dominates public and private sector understandings of the process—as a set of distinct linear stages moving from research (both basic and applied) to development, then demonstration, and finally deployment.[31] Basic research, with the goal of advancing fundamental knowledge, raises possibilities for new technologies; applied research tests the possibilities and improves on the best candidates. Development comes up with the actual products or processes

that can be put into practice. Demonstration, as the term suggests, represents the activities associated with installing, running, and monitoring the performance of these products or processes. Deployment (or diffusion) is the successful culmination of the process: the manufacturing, selling, installing, using, and maintaining of a new technology across a broad market. Even today, corporations manage their research and development with stage-gate processes that follow this linear model, and the federal government allocates funds with these stages in mind.

Over the past 50 years, though, studies[20,23,25,32–36] have shown that innovations rarely originate with inventions in basic research, nor do they follow this linear sequence of events. Instead, most innovations are more complex than government policies and practices imply. The innovation process typically involves multiple feedback loops by which the downstream activities of development and deployment generate both new problems and new knowledge that change the agendas of the upstream stages of research and development. These feedback loops may take place within a single stream of scientific or technological development, but they can also take place across multiple streams.

Historically, the federal government's largest impacts on economic development, national security, and public health and welfare came through funding and support (through investment and procurement) that directly brought new science and technology all the way to industrial production and use.[20] Considerable innovation also occurred in downstream activities through learning by doing and learning by using.[36] For example, the Internet's properties and uses have continually shifted in response to emergent opportunities that were not initially anticipated. Similarly, the American system of manufacturing (the foundation of mass production), which grew out of efforts to build armories, arose through the coevolution of machine tools, manufacturing methods, and firearm design that took place throughout the 1800s. Other examples of nonlinear effects can be seen in the development of the steel industry, antibiotics, and the space program, all of which required federal involvement. Thus, projects provide more value—in terms of knowledge generated and social benefit—when the government is involved in all aspects of innovation, including basic research as well as initial deployment.

Given these findings, federal policies need to be designed so that knowledge and resources developed in downstream industrial efforts can more readily inform and support upstream scientific efforts. To achieve this goal, the federal government should

- help to establish long-term, technology-specific collaborations between industry, academia, and government focused on advancing science and practice aimed at grand challenges, such as climate change, and
- solicit and fund collaborative research projects that connect university and industry researchers and expose early-career scientists to the knowledge, resources, and challenges of industry.[37,38]

Because many innovations represent the combination of science and technologies developed across multiple streams,[39] policymakers should also support efforts that integrate existing streams of science and technology instead of funding only efforts aimed at inventing or discovering new knowledge. The wisdom of this approach becomes evident when one realizes that American agricultural productivity benefited dramatically in the late 19th century from the integration of several parallel processes: the development of new crop breeds, the use of mass-produced agricultural harvesting equipment, and the federally funded development of rail transportation. Likewise, modern smartphones are built on independent and interdependent advances in semiconductor, radio, GPS, software, and Internet science and technology. Today, smartphones are playing a central role in the emergence of innovations in the collection, analysis, and use of big data files containing information on millions of activities and transactions in all segments

47%

US employment at risk from automation over the next 20 years

in 31 states the most common job is a truck, delivery, or trailer-tractor driver

1945

the year the Roosevelt Government published *Science: The Endless Frontier,* the first Innovation policy

Ways for Policymakers to Enhance Innovation in the United States

PROBLEM: Technological innovation is an ongoing process of nonlinear development and interactions, wavering from a set of consistent steps. How can policymakers help manage this process to ultimately maximize both its potential profits and its social benefits for society?

SOLUTION: Provide incentives for communication at all levels of technological development: among researchers in different labs and fields; among industry, academia, and government; among agencies within the government; among international entities; and among laypeople and experts.

PROBLEM: The private sector alone has neither the resources nor the capabilities to develop the innovation infrastructures necessary to facilitate commercial success. This leaves the government to play a critical role in building innovation infrastructures. What can policymakers do to successfully support the private sector in developing the necessary infrastructure for innovation?

SOLUTION: Support efforts to integrate existing streams of science and technology by funding and encouraging knowledge sharing and learning across basic and applied research, development, demonstration, and deployment activities.

PROBLEM: Innovations rarely originate from only one source; rather, they are influenced by many different technologies' streams of ideas during the process of development. What steps can government take to influence innovation in the context of these complex and interacting feedback loops?

SOLUTION: Provide incentives for devising new uses for existing technologies and hasten the repurposing by enabling downstream industrial efforts (when technologies are already being commercialized) to readily provide feedback to upstream activities (such as basic research and early development of technologies).

PROBLEM: Innovation is a significantly more complex process than some government policies and private sector practices reflect. How can governments correct potentially inaccurate knowledge of managing innovation while also increasing the likelihood of success in the complex innovation process?

SOLUTION: Develop training programs for people charged with managing innovation. Teach managers how to cope constructively with conflict and competition among actors; to facilitate convergence on policies, regulations, standards, and platforms that underlie technological innovation; and to engage actors from many realms in the innovation processes.

of society. To better foster the integration of existing streams of science and technology, the government could

- fund promising university and industry programs that focus on bridging previously disconnected research streams (for example, data analytics and agriculture; nanotechnology and energy efficiency; and microbiology, food production, and infant nutrition) to address specific problems, and
- revise established policies that unduly constrain the recombination of extant knowledge and technologies for new applications (such as problematic policies in the domains of research funding, intellectual property rights, and resource management).

At the same time, any policies for innovation should emphasize procedures and incentives that allow technologies to be put to new uses over time.[37] Government-led efforts in the development of physical infrastructure, such as highways and communication systems, have been most successful when the government was open to new uses and repurposing. History shows that, whether targeted at specific, scaled end goals (for instance, the interstate highway system was originally meant to facilitate unencumbered military movement across the country) or launched to facilitate exploratory development (for instance, ARPANET, which evolved into the Internet, was meant to test ways for computer users to interact), innovation infrastructure efforts characterized by openness and malleability can do more than create direct value: they can enable further developments. As in natural ecosystems like oceanic reefs, it takes some time for communities to emerge around such platforms, but once the communities take hold, the supported diversity can be vast. In fact, the benefits to society can dwarf the vision of early proponents and far exceed the expected returns that were used to justify the initial investment. Thus, procedures that foster diverse uses should be considered in designing innovation infrastructures.

Managing Innovation Processes

A review of the research literature indicates that most innovations, particularly the large and complex ones, are neither predictable nor controllable by a single actor.[40] Moreover, behavioral science studies of the innovation process suggest that much received wisdom about managing innovation is questionable, including the value placed on business plans, budgets, and administrative review procedures.[35] Nevertheless, the government can help to increase the odds of innovation success by designing and carrying out training programs that will teach innovation

managers, both in and out of government, skills and practices that have been found to increase the prospects for success. (One example of a training course in managing innovation and change is available from the University of Minnesota at http://z.umn.edu/ahvmgmt6050.)

"the benefits to society can dwarf the vision of early proponents"

Skills that innovation managers should have include the following:

1. Managers need to learn ways to cooperate, compete, and conflict constructively with different stakeholders involved in building various components of an infrastructure for innovation, ensuring that they promote, rather than inadvertently interfere with, the innovation process. As A. P. Usher powerfully illustrated in his 1954 history of mechanical inventions, innovations are not produced by the inventive act of a single entrepreneur at a discrete point in time. Instead, the innovation process involves an accretion of numerous events in building infrastructures that require entrepreneurial roles by many public- and private-sector actors over extended periods of time.[25] These public- and private-sector actors both cooperate and compete with each other as they build the infrastructure needed to support a technological innovation. A recent well-known example is the development of an intranet and, subsequently, the Internet through many interactions among public- and private-sector actors performing numerous roles in the areas of research, financing, regulation, standards, and maintenance of the technological advances.

2. Managers must learn negotiating skills for adapting to periods when stakeholders diverge on policies, regulations, standards, and platforms that underlie technological innovation. Research shows that convergence on these aspects is critical to success.[41–43] Convergence depends on clarifying intellectual property and processes for sharing and codevelopment, as well as on ongoing adaptations, as the underlying sciences, technologies, industry structures, and regulations coevolve over time.

3. Managers have to devise ways to enable various stakeholders to participate in and work together on innovations. Infrastructures need engaged participation from people in the public, private, and not-for-profit sectors, although the specific ways people contribute will vary and change over time. *Engaged participation* means that people participate voluntarily because they realize that they benefit from doing so. In a 2016 book, Dougherty illustrated the profound need for cooperation in the highly complex process of drug discovery, which can involve interactions among thousands of people.[23] Through interactions in which information or perspectives are shared, these individuals, each with a partial image of a complex problem, can collectively construct a representation that works and outstrips the capacity of any single individual. As noted by Taylor and Van Every in their book *The Emergent Organization: Communication as Its Site and Surface*, "Out of the interconnections, there emerges a representation of the world that none of those involved individually possessed or could possess."[44]

4. Government innovation managers, in particular, need to also develop incentives for more cooperation in the development of innovations. The current system of government incentives for research and development encourages just the opposite: competition and incremental science. For example, many universities and research laboratories fund their research positions through National Science Foundation and National Institutes of Health grants, and funds for a common kind of grant—the R01, which pays for circumscribed projects—are always scarce.[38] Consequently, researchers in competition for the same pool of scarce funds tend to avoid helping one another, such as by not sharing

"These guidelines are not merely theoretical"

enzymes or mice, yet such sharing would save time and effort. Consider the importance of mice for many of these individuals: when applying for an R01 grant, an investigator must already have the major tools for the proposed project (such as a genetically modified colony of mice) at the ready. It can take 2 years to develop a colony that breeds true to the needed attribute, however. That stumbling block makes the risk of doing something exploratory extremely high, so scientists often resort to study designs that will allow them to use the mice (or enzymes, or drugs, and so on) they already have available. Clearly, government incentives are needed to encourage collaboration between researchers over longer time periods, which would enable more radical, less incremental research.

These guidelines are not merely theoretical. The government is putting them into practice in some of its innovation activities. A good example is the federal Big Data Research and Development Initiative.[45–48] It started in 2012 with attempts to put into practice key dimensions of behavioral science understanding of nonlinear innovation systems. It organized regional innovation hubs focusing on distinct needs (including health care, coastal hazards, manufacturing, agriculture, and education in addition to precision medicine, finance, energy, and smart cities) of specific regions of the country, as well as cross-sector collaborations to leverage public–private–nonprofit partnerships. The initiative also provides incentives to make public and private data more widely accessible to researchers and entrepreneurs and includes integration efforts to connect data sources that have been fragmented.

CancerLinQ is one project involved in the initiative. It is an effort to assist oncologists in improving cancer treatment by collecting the data on the care of cancer patients that is stored in electronic health records.[49] Such information would be very hard to pull together if only competing, private-sector entities were involved. A second example is funding for the Amazon Web Services (AWS) cloud, which is a private platform, to provide public access to the largest data set on human genetic variation, developed through the 1000 Genomes Project. Few researchers have the computing power or storage capacity to house the data set; AWS uses the cloud to provide infrastructure for data analysis at enormous scale. The AWS project also typifies the initiative's use of international public–private collaborations, bringing together researchers and institutions from several countries.[50–52] Finally, the initiative explicitly promotes the broad participation that catalyzes innovation by engaging with civic groups and other grassroots organizations.

Conclusion

We have focused here on two issues related to technological innovation that have significant long-term costs and benefits to society. First, technological innovations in control systems and information technology are replacing many jobs or shifting them so that they are performed by independent contractors with no health care, unemployment, disability, or pension benefits. The affected workers need a safety net.

Second, contrary to old ideas, research shows that innovations do not follow a linear sequence of stages, beginning with basic and applied research and moving downstream through development, demonstration, and diffusion. We explored several important implications of this understanding for innovation policy as well as for how government agencies themselves manage their own innovation processes.

We suggest that policymakers convene meetings to discuss the public policy implications of technological innovations with relevant stakeholders in the public, private, and nonprofit sectors; the involvement of all these parties is crucial to the success of any plans intended to minimize the negatives and enhance the positives of the technological trends facing the nation today.

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