Beyond Nudges: Tools of a Choice Architecture[1]

Eric J. Johnson, Center for Decision Science, Columbia Business School, Columbia University

Suzanne Shu, Anderson School of Management, UCLA

Benedict G. C. Dellaert, Department of Business Economics Erasmus School of Economics, Erasmus University

Craig R. Fox, Anderson School of Management, UCLA

Daniel G. Goldstein, Yahoo! Research and London Business School

Gerald Häubl, School of Business, University of Alberta

Richard P. Larrick, The Fuqua School of Business, Duke University

Ellen Peters, Department of Psychology, The Ohio State University

John W. Payne, The Fuqua School of Business, Duke University

David Schkade, Rady School of Management, UCSD

Brian Wansink, Applied Economics and Management Department, Cornell University

Elke U. Weber,, Center for Decision Science, Columbia Business School, Columbia University

[1] Preparation of this chapter has been supported by NIA Grant 5R01AG027934 to the first author.

Beyond Nudges: Tools of a Choice Architecture

Choice Architecture, a term coined by Thaler and Sunstein (2008), reflects the fact that there is more than one way to present a choice to the decision-maker, and that what is chosen often depends upon how the choice is presented. Choice architecture implies that there are choice architects, by analogy to the architect of a building who determines many of the behaviors of the building's users through the placement of doors, hallways, offices, and bathrooms. Architects of choice can influence what is chosen by varying the order of presentation, the salience of different kinds of information, and the selection of defaults, to name just a few of the tools available in the presentation of a given choice. While it is tempting to think that choices can be presented in a 'neutral' way ("Just the facts, Ma'am"), the bottom line is that there is no neutral architecture, i.e., any way of presenting a choice will influence the decision-maker in some way. For example, all ways of presenting a choice have a (usually implicit) default, and the default option will be chosen more often than if another default option had been selected by the architect. Thus there is no such thing as a neutral choice environment and everyone, from a parent presenting bedtime options to a child, to a government providing pension options to its citizens, is a choice architect.

In this brief paper, we try to provide some examples of the kinds of tools that are available to a choice architect. We eschew, for the time being, any attempts at providing a theoretical account of why these tools affect choice. Similarly, we do not provide a normative analysis of how a choice architecture ought to be designed,

or when to use which tool. Our modest goals for this paper are to simply identify some of the tools of a choice architecture and to provide a few brief examples of their application. We divide our list of tools into two broad categories, those used in structuring the task, and those related to formatting the choice. We then turn to how these tools may raise challenges in implementation and provide some examples.

Structuring Choices.

Number of Alternatives

One of the most important decisions facing a choice architect is the question of how many alternatives (options) to present to the decision maker. Should the decision maker be presented with one option at time, two options, three options, or more options - even 10, 20, or 100 or more options? Clearly there can be times when a person has too few options to select from, such as when the original Ford Model T offered the choice of any color – as long as it was black. At other times, there can be the danger of too many options or what Schwartz (2004) has called the tyranny of choice. For example, the number of Medicare drug benefit plans available to U.S. seniors now exceeds 100 in some states. Furthermore, the trend in the marketplace is for more, not less options to be presented to the consumer.

To answer the question of how many options to present, the choice architect needs to consider various criteria including a) the option selected and how closely it matches a person's values (the strongest argument for more options is that it should increase the chances of offering a preference match to the consumer), b) the

willingness of the decision maker to even engage in making a choice, c) how satisfied the decision maker will be with the decision process and the decision made, d) the speed and effort needed to make the decision, and more generally e) the nature of the processes that will be used to make the decision. Finally, the architectural question should be answered contingent upon who the decision maker will be. Older adults, for instance, seem to prefer less choice than younger adults (Reed, Mikels, and Simon, 2008).

Given the vast amount of research on the topic of the effects of number of alternatives on decision behavior (see Payne, Bettman, & Johnson, 1993; Scheibehenne, Greifeneder, & Todd, 2010), it is impossible to give a one size fits all answer to the question of what the optimal number of alternatives to present is. One recommendation, made by Payne, is that five options plus or minus one is a reasonable starting value for the choice architect given the design tradeoffs. The logic is that one wants the fewest number of options that will encourage a reasoned making of tradeoffs among conflicting values (assuming at least three dimensions of value needs to be considered), and yet not seem too overwhelming to the decision maker. Of course, one would always want to provide the decision maker with the option of considering more than five plus or minus one, if desired.

Defaults

One of the most powerful and popular tools available to the choice architect is the use of defaults. Defaults are settings or choices that apply to individuals who do not take active steps to change them (Brown & Krishna, 2004). Collections of default settings, or "default configurations" determine the way products, services, or

policies are initially encountered by consumers, while "reuse defaults" come into play with subsequent uses of a product. At the finest level, a single question can have a "choice option default", which on electronic forms can take the shape of a pre-checked box (Johnson, Bellman, and Lohse, 2002).

Defaults have been shown to have strong effects on real-world choices in domains including investment (Cronqvist & Thaler, 2004; Madrian & Shea, 2001), insurance (Johnson et al, 2003), organ donation (Johnson & Goldstein, 2004), marketing and beyond (Goldstein et al, 2008). They appeal to a wide audience in their ability to guide choice, while at the same time preserving freedom to choose, and are often regarded as prototypical instruments of libertarian paternalism (Sunstein & Thaler, 2003).

Through default-setting policies, choice architects can exhibit influence over resulting choices (Goldstein et al., 2008). The palette of policies includes simple defaults (choosing one default for all), random defaults (assigning a configuration at random, for instance, as an experiment), forced choice (withholding the product or service by default, and releasing it to the recipient only after an active choice is made), and sensory defaults (those which change according to what can be inferred about the user, for example, web sites that change language dependent on country of origin of the visitor). Products and services that are re-used can also avail themselves of persistent or reverting defaults (which respectively remember or forget the last changes made to the default configuration) and predictive defaults (which intelligently alter reuse defaults based on observation of the user).

Choice architects should be aware of the ethical risks involved in setting defaults (Smith, Goldstein & Johnson, 2010). The ethical acceptability of using a default to guide choice has much to do with the reason why the default is having an effect. When consumers are aware that defaults may be set as recommendations in some cases, or manipulation attempts in other cases (Brown & Krishna), they exhibit a level of "marketplace metacognition" that suggests they retain autonomy and freedom of choice. However, if defaults have an effect because consumers are not aware that they have choices, or because the transaction costs of changing from the default are too high, defaults impinge upon liberty. An often-prudent policy, though not a cure-all, is to set the default to the alternative most people prefer when making in active choice, without time pressure, in the absence of any default. Running an experiment on a sample of the population can determine these preferences, and can be done in little time and at a low cost in the age of Internet experimentation (Gosling & Johnson, 2010).

Choice over time

Many of the choices individuals face involve outcomes that unfold over long periods of time. The intertemporal structure of a task has important implications for both the decision maker and the choice architect. The influence of any time delay in decision outcomes on choice is felt in three specific ways. First, individuals tend to be myopic and want good outcomes early; this results in individuals giving in to immediate temptations and/or heavily discounting future outcomes (Ainslie 2001, Loewenstein & Elster 1992). Second, uncertainty about the future can cause individuals' preferences for future outcomes to be unclear, such that certain types of

outcomes are systematically over- or underweighted. For example, uncertainties in life expectancy can lead to underconsumption of financial products with future payouts such as savings, annuities, and reverse mortgages (Brown 2007, Börsch-Supan 2003, Davidoff, Brown, and Diamond 2005), and uncertainties about the likelihood and extent of global climate change seems to reduce the political will to take mitigative action (Hansen, 2009).. In dealing with this uncertainty, the decision maker can become overly focused on certain highly salient or desirable future outcomes and fail to plan for alternatives (Koehler 1991, Shu 2008). Third, individuals are often overly optimistic about the future and assume that they can accomplish more than they actually will. They expect to have both more time and money in the future than they do today and overestimate the probability that desired outcomes will occur as planned (Zauberman & Lynch 2005, Kahneman & Lovallo 1993).

Tools are available to the choice architect to address each type of intertemporal bias. To deal with an outsize focus on desirable future outcomes, choice architects can actively direct the decision maker's focus to secondary outcomes, which has been found to produce choices more consistent with optimal normative behavior (Weber et al., 2007; Shu 2008). Finally, behaviors associated with holding an overly optimistic perception of the future can be addressed through the enforcement of limited windows for task completion. For example, big city residents who procrastinate visiting local landmarks due to an assumption they can do it later may benefit by acting more like tourists whose limited window for sightseeing motivates them to action (Shu & Gneezy 2010). Putting expiration dates

on policy initiatives like home energy efficiency improvement tax credits (http://www.irs.gov/newsroom/article/0,,id=206871,00.html) is another example. In general, tools that translate aspects of the choice into immediate salient outcomes are more successful than those that attempt to manipulate heavily discounted future costs and benefits.

Formatting Choices

Partitioning Options and Attributes.

One inescapable facet of choice architecture is the way in which the set of options, attributes, or events are partitioned into groups or categories. This seemingly innocuous feature of a choice environment can have a dramatic impact on choice behavior.

When people allocate a limited resource (e.g., money, choices, probabilistic belief, importance weights) over a fixed set of possibilities (e.g., investment opportunities, consumption options or time periods, events or attributes), they are typically biased toward even allocation over each group or category that has been identified. Thus, in personal investment, people are tend toward allocating $1/n$ of their savings to each of the n options that are singled out in a 401(k) plan (Benartzi & Thaler, 2001); in consumer choice, people tend to seek variety when choosing multiple goods for future consumption (Simonson, 1990; Read & Loewenstein, 1995), and they tend to favor spreading out consumption over different time periods (Loewenstein & Prelec, 1993); in distributive justice, people tend to favor

equal allocation of benefits and burdens among individuals unless there is a compelling alternative criterion (Messick, 1993); in decision analysis, people are biased toward assigning equal probabilities to each event that could occur (Fox & Rottenstreich, 2003; Fox & Clemen, 2005) and equal importance weights to each attribute that is explicitly identified (Weber, Eisenführ & von Winterfeldt, 1988).

This pervasive tendency toward even allocation provides a powerful tool to choice architects: judgments and choices can be strongly influenced by the particular groups or categories into which the set of possibilities is partitioned. Thus, by assigning favored investment options to separate superordinate categories (e.g., domestic and international stock index funds to vendors A and B) and disfavored investment options to a single superordinate category (e.g., several high-load exotic mutual funds to vendor C), one can nudge greater investment into the favored options (see Langer & Fox, 2009; Bardolet, Fox & Lovallo, in press). By segregating healthy menu options into separate menu categories (e.g., "fruits", "vegetables") and integrating unhealthy options into a single menu category (e.g., "cookies and crackers") one can nudge participants to choose a greater number of healthy options and smaller number of unhealthy options; likewise, by segregating later time periods into separate categories and integrating earlier time periods into a single category one can induce greater patience in consumption (Fox, Ratner & Lieb, 2005). By splitting more important attributes (e.g., "practicality" of an automobile) into a greater number of sub-categories (e.g., "safety", "gas mileage", "warranty") and combining less important attributes into a single category (e.g., "Stylishness--design, stereo, horsepower") one can increase the importance given to

the more important attributes when consumers choose among product offerings (Martin & Norton, 2009).

A unique virtue of using partitioning to nudge decision makers toward desired behaviors is that the impact of this intervention will tend to be strongest among decision makers with weaker intrinsic preferences or beliefs and diminish or disappear among those with stronger intrinsic preferences or beliefs (Fox, Bardolet & Lieb, 2005). For instance, in one study wine novices asked to choose among several different varieties of white wine were more likely to diversify over grape if wines were grouped by grape type and they were more likely to diversify over country of origin when wines were grouped in that manner; this effect was greatly attenuated among wine experts (Fox, Ratner & Lieb, 2005). Thus, partitioning will tend to exert the strongest paternalistic influence on those who need the greatest guidance and it will have the weakest effect on those who require the least guidance.

Designing Attributes

People choose between alternatives by weighing their pros and cons on different attributes, and choice architects influence behavior when certain attributes are made more or less salient. For example, car buyers will consider attributes such as style, cost, safety, reliability, capacity, and fuel economy. These attributes may be important in their own right or because they help decision makers achieve more fundamental objectives. An ideal decision incorporates all of the relevant attributes and weighs them to the degree that allows decision makers to achieve their objectives. The choice architect can help people attend to and use attributes accurately by adhering to the principles of parsimony, linearity, comparability, and

evaluability. In addition, decision architects may choose to make some attributes, such as those with externalities that might otherwise be neglected, more salient by using the tools of attribute translation and attribute expansion.

When the choice architect's goal is to improve the decision maker's accuracy in attribute use, the first available tool is parsimony. Overwhelmed by too many attributes, people may simplify their decision by focusing on only one. Decision makers can understand more information and weigh important information better in choices that require less cognitive effort, especially for less numerate consumers (Peters, Dieckmann, et al., 2007). Less cognitive effort can be achieved through providing fewer attributes and highlighting the meaning of only the most important attributes. The choice of attributes can be based on a "typical consumer" but, with technology, can also be tailored by letting consumers choose attributes from a menu.

Linearity is also an important tool for improving accuracy. Common but important decision attributes may have a non-linear relationship to a more fundamental objective. For example, people expect that monthly credit payments have a roughly linear relationship to payback period; in reality, payback period increases sharply when monthly payments barely cover interest. To correct these misperceptions, new credit card statements must now list the monthly payment needed to eliminate a balance in 3 years. Similarly, several measures of energy efficiency, such as miles per gallon (MPG) ratings for cars and SEER ratings for air conditioners, have a reciprocal relationship to energy consumption. However, people use differences in these numbers to estimate energy savings. As a result,

they undervalue the energy savings from improving inefficient cars (Larrick & Soll, 2008). These misperceptions are fixed by converting MPG to an energy consumption measure such as "gallons per 100 miles" that is linear in energy savings.

The final two tools for improving accuracy are comparability and evaluability. For decisions where the same attribute is expressed differently across contexts (e.g., annual newspaper subscriptions, monthly cable bills, and per use music downloads), placing the activities or products on the same scale allows decision makers to compare their relative value more accurately. For highly quantitative information that can be difficult for people to process because the numbers are challenging or the domain is unfamiliar, numbers become more easily evaluated if they are broken into categories, such as grades, or if they have endpoints clearly labeled as good or bad. For example, newly proposed EPA labels contain information about carbon dioxide emissions, but no one is familiar with what is a "good" or bad" level of CO2. Peters, Dieckmann, et al. (2007) demonstrated that decision makers could integrate more information into judgments when numbers were supplemented with evaluative labels and showed that the labels facilitated information processing by allowing affect to be accessed more quickly.

For situations where the choice architect wishes to increase the use of certain attributes, the tools of attribute translation and attribute expansion can be helpful. This is desirable if an attribute is important to a decision maker but might be otherwise neglected. Research by Bond, Carlson & Keeney (2008) showed that

people bring to mind only half the objectives they care about in a decision. Thus, there is a benefit to translating an attribute to show the consequences it has for other objectives. For example, a car's gas consumption is directly related to the cost of driving the car and to the CO2 emissions from the car. However, people may fail to translate gas consumption to either scale because the math is challenging or they do not recognize the consequence on that objective unless reminded of it. The newly proposed EPA labels translate gas consumption to both driving costs and CO2 emissions to draw more attention to these objectives. A second factor that increases the use of an attribute is changing the scale on which it is expressed. For example, a car's gas consumption can be expressed over short distances (100 miles) or long distances (10,000 miles). Expanding the denominator makes the numerators larger and makes the differences between alternatives appear larger, allowing these expanded attributes to receive more weight in choice (Burson, Larrick, & Lynch, 2009).

Technology and Decision Aids

As technology continues to permeate our world, more and more of the choices we make involve the use of some form of information technology (Murray, Liang, and Häubl 2010). For instance, we increasingly choose what to buy, what activities to participate in, or what to attend to via some form of desktop or mobile computer interface. Moreover, we may use technology-based tools such as search engines or product recommendation systems to help us identify attractive choice alternatives that we were not aware of, and to filter out ones that are not of interest to us (Bodapati 2008; Häubl and Murray 2006; Xiao and Benbasat 2007). We can

also enlist the assistance of interactive decision aids that help us compare choice alternatives in terms of their attractiveness on various feature dimensions (Häubl and Trifts 2000). Yet another way in which the choices we make are increasingly facilitated by technology is the automatic personalization of user interfaces to reflect our preferences (Hauser et al. 2009; Price et al. 2006). This interaction with decision technology is likely to increase in future years as we continue to make advances in the areas of ubiquitous computing and ambient intelligence (Aarts and Encarnação 2006, Krumm 2009), "smarter" physical environments (Streitz, Kameas, and Mavrommati 2007), a smarter energy grid and interface with human users (e.g., http://www.bu.edu/energy/research/smart-neighborhood/) and more powerful pocket-sized, wearable, or even implantable mobile devices that assist in interacting with our environment (Acampora et al. 2010; Cook and Song 2009).

Research has demonstrated that decision aids such as product recommendation systems can be highly beneficial to consumers, enabling them to find products that better match their preferences while at the same time reducing search effort (Häubl and Trifts 2000). However, these tools can also predictably influence consumers' choices through very subtle architectural features such as the context in which alternatives are presented (Cooke at al. 2002) or which product attributes are made more salient by the system (Häubl and Murray 2003). Thus, technology-based decision aids could be designed to steer consumers towards choosing products, services, or activities that are desirable – i.e., healthy, environmentally friendly, socially beneficial, etc. – without restricting their freedom to choose. Given that consumers appear to show little resistance to such influence

when it benefits profit-seeking sellers (Häubl and Murray 2006), they should be even more willing to accept such nudges when these are actually in their own and/or society's interest.

How Formatting Affects Search

The formatting of the decision task does not only affect the way in which consumers make choices, it also has implications for decision making in the context of search. There is a subtle transition path from choice to search that has received relatively little attention in the literature, but that has implications for the way in which consumers make decisions and how these decisions can be supported. In a typical choice context, a consumer needs to decide between a relatively small set of alternatives and typically is asked to choose one product (e.g. buying grocery products, buying clothing, choosing a certain service provider, etc.). As the number of alternatives expands, consumers may use different strategies to deal with complexity than in this classical choice context. These strategies affect consumer choice outcomes differently and therefore suggest different tools of choice architecture. For example, Levav et al (2010) recently found that the order in which consumers make decisions in customization processes that have many options affects the likelihood that they select the default for each separate decision. Thus, the selection of the defaults for each separate decision and the sequence in which they are offered are also tools of choice architecture.

Consider the situation where consumers follow a two-stage decision making strategy to deal with choices from many alternatives. This typically involves a first

screening step of alternatives on the basis of a subset of attributes and a second step of alternative-based comparisons for the remaining considered set of alternatives after screening (Hauser and Wernerfelt 1990; Payne 1976). In this context, formatting the screening stage by facilitating comparisons on a certain attribute and not others will influence consumer choice (Diehl, Lynch and Kornish 2003).

When taking a search-oriented approach to dealing with many alternatives, consumers consider the total distribution of values of alternative in the market and the cost for inspecting each alternative, thus allowing them to determine how many total alternatives to include in the search. They sequentially compare the subsequent (expected) most attractive alternatives to a reservation value to determine if they should accept the alternative or not (Weitzman 1979). Recent research shows that consumers are prone to make sub-optimal decisions in these search decisions (Häubl, Dellaert and Donkers 2010, Zwick et al. 2003). Formatting the decision task can help the decision maker do better; for example, ranking alternatives in order of expected attractiveness can be an effective way to improve search outcomes (Haübl and Trifts 2000). An additional search formatting approach that is helpful to consumers is to provide easier access to information about the distribution of product values in the market when consumers are not familiar with the market (Rosenfield, Shapiro, and Butler 1983).

Implementing Choice Architectures.

Individual differences

Choice architecture at its best promises better decisions, healthier lives, and improved finances. But some early "nudges" have gone wrong simply because a nudge can have multiple effects that depend on individual characteristics. For example, informing households about their relative energy use led to an average 2% decrease in energy usage, but the change depended on the household's political affiliation. Liberal households reduced their consumption, while Republicans increased theirs, presumably due to differences in environmental concerns (Fisman, 2010). In related research, Dan Kahan and his colleagues illustrate the important role played by cultural cognitions in how individuals interpret and react to information about diverse risks (e.g., climate change, gun control, outpatient commitment laws, the HPV vaccine; Kahan et al., 2009).

As this risk-perception research illustrates, individual differences will matter to how choice architectures play out in the market. As the eminent learning theorist Hobart Mowrer once said, "To understand or predict what a rat will learn to do in a maze, one has to know both the rat and the maze" (Mowrer, 1960, p. 10). In similar fashion, choice architects will have to design decision environments faced by decision makers in light of knowledge about the decision environment (this is already being done) but also with knowledge about the characteristics of targeted decision makers (and how they will process and draw meaning from information). In some cases, the right choice for choice architecture may differ by these individual characteristics. Policy makers insensitive to this possibility may find that their best

efforts at choice architecture leave some individuals without intended assistance and produce unintended consequences in other cases.

Why might this be the case? Good communicators, including choice architects, attempt to maximize effectiveness by tailoring communications to what their audience knows and believes. The problem is that this model of "the other person" depends on communicators anchoring first on what they themselves know, and then adjusting for the other person. That adjustment process, however, can be insufficient, resulting in a so-called "curse of knowledge" that leads communication attempts to be less successful than desired (Nickerson, 1999, 2001). In addition, communicators often overestimate how well they communicate, leaving them without appropriate feedback to improve later communications (Keysar, 2007).

The implication is that the intuitions of choice architects will not always be enough and that choice architectures should be tested in diverse populations of interest. However, we already know quite a bit about how individual differences influence decisions and how they interact with situations. An understanding of what individual differences might be important to particular content domains (e.g., cultural cognitions in environmental domains) or types of decision problems (e.g., numeracy in decisions with unfamiliar numeric information) can be brought to bear already on the emerging science of choice architecture.

For example, a series of studies have been conducted examining the interaction of numeracy with how information is presented or framed (Peters, Dieckmann, et al., 2007, 2009; Peters et al., 2006; Sagara, 2010). We know that

requiring less cognitive effort will help decision makers understand more information and weigh important information more in choices, and this is particularly true for less numerate consumers. Attaching affective meaning to numeric information allows decision makers to integrate more information and, for those who are less numerate, results in reduced reliance on less relevant, emotional sources of information such as mood states. However, while the use of an organizing framework helped less numerate consumers to better comprehend information that was summarized in the framework, it hurt their comprehension of other information. The use of traffic-light indicators similarly hurt comprehension of less numerate individuals whereas the provision of number comparisons can cause highly numerate decision makers to overuse them. A one-size-fits-all approach to choice architecture will not always work, particularly in the diverse and sometimes highly politicized U.S. environment for which these architectures are being built.

Evaluating Outcomes

How can we tell if a choice architecture intervention has helped a decision-maker? One answer is to consider the decision maker's experience of the selected choice outcomes. Most treatments of choice assume that the utility of an outcome measured ex ante equals its utility when it is experienced ex post (i.e., stationarity). However, a growing body of research has documented numerous ways in which people can fail to accurately predict how they will feel about the outcomes of their choices (Loewenstein and Schkade, 1999; Hsee and Hastie, 2006). People often overestimate the impact of differences in income on well being (Kahneman et al.,

2006), underestimate the impact of an empty stomach on their grocery shopping decisions (Nisbett and Kanouse, 1968), make professions of love during moments of lust, and believe that they can "eat just one chip". A related problem is the underprediction of adaptation to enduring changes (Schkade and Kahneman, 1998; Smith, 1759). For example, Gilbert et al. (1998) demonstrated that people greatly overestimate the duration of their emotional responses to the denial of tenure and the breakup of a romance. But there is evidence that people who have experience in a situation make more accurate predictions about adaptation (Schkade and Kahneman, 1998).

Some features of existing policy and choice environments reflect at least a tacit knowledge of these phenomena. For example, many consumer protection laws provide “cooling off” periods, during which a consumer can cancel a choice without penalty. One function that experienced agents and advisors often serve is to encourage a decision maker to consider not only the features of an option that are salient at the point of choice, but also those that will be more important when the outcomes are experienced. These and other interventions that bear on the decision maker’s knowledge of their future outcomes should be considered part of the decision architect’s toolkit.

Applications of the Tools of Choice Architecture

The concept of choice architecture has already diffused into several economics and public policy domains where individuals regularly experience suboptimal decisions. Choice architecture tools have been applied to issues of

consumer savings, organ donation, medical decision-making, consumer health and wellness, and climate change. Here, we focus on three primary domains: decision for a sustainable environment, consumer financial decisions, and eating decisions.

Consider first the domain of decisions that impact our environment. This may include decisions regarding energy consumption (appliances, transportation, heating and cooling), water use (including showers, gardening, swimming pools, rice farming), and land use (deforestation, types of agriculture, city planning). Some environmental decisions have substantial long-run implications; potential climate change risks are perhaps the greatest sustainability challenge, and require drastic reductions in Greenhouse Gas (GHG) emissions through less energy consumption and efficiency and conservation measures. Producing these reductions can offer both financial gains for consumers and societal gains for the environment, seemingly a win-win situation. While purely economic solutions have been attempted, the psychological biases that are a barrier to adoption make this a domain where behavioral change may prove more effective.

The second application domain is the area of consumer financial decision-making. We have already seen the impact of choice architecture on both innovative product offerings, and in public policy. The Save More Tomorrow plan (Thaler and Benartzi, 2004) first reframes the decision to save: Instead of reducing consumption now, the participant decides how much of a future increase in salary will be allocated to savings. By moving the decision into the future, the intervention also takes advantage of impatience. Finally the plan also makes the increased saving the default. Together, these three changes have significantly increased savings

behavior and have generated widespread adoption. A change of default in debit and credit cards has also recently produced a significant change in the structure of profits in that industry. The Credit CARD Act changes the default for over-limit fees on Debit and Credit cards, requiring an opt-in choice to enable the bank to pay bills over the amount in your account. These fees, often greater than $30, were an important source of profit. As a result of this change, Bank of America took a write-off of greater than $10.4 billion dollar in the value of its credit card unit (Schwartz, 2010).

Finally, consider the domain of eating decisions. While many individuals spend significant amounts of time, effort and money in attempts to modify their diet, most eating behavior occurs without much thought. Yet given that people make an average of 200 to 300 decisions regarding food consumption in any given day (Wansink and Sobal 2007), it is no wonder that individuals might make decisions that are out of line with their health goals and desires. In order to reduce the cognitive requirements of so many decisions, individuals may rely on heuristics or decision-rules to guide food choice and consumption decisions. These habitual behaviors can become rigid and unresponsive to changes in understanding of health and nutrition (Just and Wansink 2009). This makes eating behavior a prime context for behavioral economic interventions and research.

For each domain, one may wonder whether purely economic solutions can be leveraged to affect behavior. For the environment, economic solutions have included regulating behavior (through building codes and CAFE efficiency standards) and raising the price of energy (e.g., a carbon tax in some countries other than the US).

However, biases in discounting, inertia, and uncertainty can prevent such solutions from affecting choices. In financial decisions, purely economic incentives are not enough to improve choices; for example, even company matching on 401K contributions is not enough to achieve 100% participation in savings programs. With food consumption, psychologists have experimented extensively with behavior, finding many predictable behaviors that cannot be reconciled with standard economic models as they are now applied. For example, altering prices and information is generally ineffective in altering consumption (Mytton et al 2007) and can even have unintended consequences, such as reducing worry about other issues (Weber 1997) or increasing focus on only a single corrective action (Weber 2006). Without behavioral economic models, traditional models suggest only three policy levers: altering prices, providing information, and placing restrictions on what can be sold and where. Thus, it becomes useful to modify standard utility functions, models of time discounting, or models of information or perception that allow the psychological models to interact with the economic incentives (Just and Wansink 2009).

An emerging literature has tried to incorporate some psychology into economic models of environmental choices, financial decisions, and food consumption. While this literature represents a starting point, much remains to be done in terms of incorporating the tools of choice architecture into these domains, and creating and using suitable individual data to calibrate these models for policy purposes. Many of the choice architecture tools described in this paper were designed to change behavior in these three areas. Additional situational changes,

such as changing the background of the decision (Mandel and Johnson, 2002), the social setting of the decision (Milch et al., 2009), the method or mode used for making the decision (Weber & Lindemann, 2007), or even the label of the choice (Hardisty, Johnson, & Weber, 2010) may all have desirable effects. Such behavioral interventions are not necessarily resented by the decision-maker who is often unaware of the impacts of mechanism on their own behavior (e.g., Just, Wansink, Mancino and Guthrie 2008; Johnson and Goldstein 2003). Rather, the individual may believe they are better off for the intervention if the intervention encourages good behavior while not prohibiting bad behavior. One possible response to the charge that the choice architect is influencing behavior without the decision-maker's awareness is full-disclosure of decision design: Choice formats could be accompanied by a description of the potential influences that might accompany the way the choice is posed.

The behavioral economics of environmental sustainability, financial decisions, and eating affects us all in multiple ways multiple times a day. The good news is that the same factors that lead us to make a suboptimal or unhealthy choice can often be mindlessly reversed to help us make a mindlessly better choice. Behavioral economics offers a way to encourage more optimal behavior without inducing the resistance and reactance often associated with restrictive policies (Just and Wansink 2009). Rather, behavioral policies offer the potential of creating long lasting habits and attitudes.

References

Aarts EHL, Encarnação JL. *True Visions: The Emergence of Ambient Intelligence* Heidelberg: Springer; 2006.

Acampora, Giovanni, Matteo Gaeta, Vincenzo Loia, Athanasios V. Vasilakos. Interoperable and Adaptive Fuzzy Services for Ambient Intelligence Applications. *ACM Transactions on Autonomous and Adaptive Systems*. 2010; 5(2):1-26.

Ainslie G. *Breakdown of Will*. Cambridge: Cambridge University Press. 2001.

Bardolet D, Fox CR, Lovallo D. Naïve diversification and partition dependence in capital allocation decisions. *Strategic Management Journal,* forthcoming. (in press).

Benartzi R, Thaler R. Naı¨ve diversification strategies in retirement saving plans. *American Economic Review.* 2001;91:475–482.

Benartzi S, Thaler RH. Save More Tomorrow: Using Behavioral Economics to Increase Employee Savings. *Journal of Political Economy*. 2004; 112(1):S164-S187.

Bodapati AV. Recommendation Systems with Purchase Data. *Journal of Marketing Research*. 2008; 45(1): 77-93.

Bond, S. D., Carlson, K. A., Keeney, R. L. (). Generating objectives: Can decision makers articulate what they want? Management Science, 2008, 54, 56-70.

Börsch-Supan A. Life-Cycle Savings and Public Policy: A Cross-National Study of Six Countries. New York: Academic Press; 2003.

Brown CL, Krishna A. The Skeptical Shopper: A Metacognitive Account for the Effects of Default Options on Choice. Journal of Consumer Research. 2004;31(3):529-539.

Brown JR. Rational and behavioral perspectives on the role of annuities in retirement planning. (NBER Working Paper No. 13537). Cambridge, MA: National Bureau of Economic Research, Inc. 2007.

Burson, K. A., Larrick, R. P., & Lynch, Jr., J. G. (). Six of one, half dozen of the other: Expanding and contracting numerical dimensions produces preference reversals. Psychological Science, 2009, 20, 1074-1078.

Cook DJ, Song WZ. Ambient Intelligence and Wearable Computing: Sensors on the Body, in the Home, and Beyond. Journal of Ambient Intelligence and Smart Environments. 2009; 1(2):83-86.

Cooke ADJ, Sujan H, Sujan M, Weitz BA. Marketing the Unfamiliar: The Role of Context and Item-Specific Information in Electronic Agent Recommendations. Journal of Marketing Research. 2002; 39(4):488-497.

Cronqvist H, Thaler R. Design Choices in Privatized Social Security Systems: Learning from the Swedish Experience," American Economic Review. 2004; 94 (2):424-428.

Diehl K, Laura JK, Lynch JG. Smart Agents: When Lower Search Costs for Quality Information Increase Price Sensitivity. Journal of Consumer Research. 2003; 30 (June):56-71.

Fox CR, Bardolet D, Lieb D. Partition dependence in decision analysis, managerial decision making, and consumer choice. Chapter in R. Zwick, R. & A. Rapoport (Eds.), Experimental Business Research. Volume III. Dordrecht, The Netherlands: Kluwer; 2005.

Fox CR, Clemen RT. Subjective probability assessment in decision analysis: Partition dependence and bias toward the ignorance prior. Management Science. 2005; 51 1417-1432. (Named Best Paper in Decision Analysis 2005, INFORMS).

Fox CR, Ratner RK, Lieb D. How subjective grouping of options influences choice and allocation: Diversification bias and the phenomenon of partition dependence. Journal of Experimental Psychology: General. 2005; 134:538-551.

Fox CR, Rottenstreich Y. Partition priming in judgment under uncertainty.

Gilbert, D.T., Pinel, E.C., Wilson, T.D., Blumberg, S.J., & Wheatley, T.P. Immune neglect: A source of durability bias in affective forecasting. Journal of Personality and Social Psychology, 199, 875, 617-638.

Psychological Science. 2003;14:195-200.

Goldstein DG, Johnson EJ, Herrman A, Heitmann M. Nudge Your Customers Toward Better Choices. Harvard Business Review. 2008; (December):99-105.

Gosling SD, Johnson JA. Advanced methods for conducting online behavioral research. Washington, DC: American Psychological Association. 2010.

Häubl G, Dellaert BGC, Donkers B. Tunnel Vision: Local Behavioral Influences on Consumer Decisions in Product Search. Marketing Science. 2010;29 (3):438-455.

Häubl G, Murray KB. Preference Construction and Persistence in Digital Marketplaces: The Role of Electronic Recommendation Agents. Journal of Consumer Psychology. 2003; 13(1&2):75-91.

Häubl G, Murray KB. Double Agents: Assessing the Role of Electronic Product Recommendation Systems. Sloan Management Review. 2006;47(3):8-12.

Häubl G, Trifts V. Consumer Decision Making in Online Shopping Environments: The Effects of Interactive Decision Aids. Marketing Science. 2000; 19(1):4-21.

Hauser JR, Wernerfelt B. An Evaluation Cost Model of Consideration Sets. Journal of Consumer Research. 1990; 16(4):393-408.

Hauser JR, Urban GL, Liberali G, Braun M. Website Morphing. Marketing Science. 2009; 28(2):202-223.

Hsee, C. K. & Hastie, R. Decision and experience: Why don't we choose what makes us happy? Trends in Cognitive Sciences, 2006,10, 31-37.

Johnson EJ, Goldstein DG. Do Defaults Save Lives? Science. 2003;302:1338-1339.

Johnson EJ, Hershey J, Meszaros J, Kunreuther H. Framing, Probability Distortions, and Insurance Decisions. Journal of Risk and Uncertainty. 1993;7:35-53.

Johnson EJ, Bellman S, Lohse GL. Defaults, Framing, and Privacy: Why Opting In Is Not Equal To Opting Out. Marketing Letters. 2002; 13(1):5–15.

Just DR, Wansink B. Better School Meals on a Budget: Using Behavioral Economics and Food Psychology to Improve Meal Selection Choices. 2009 forthcoming.

Kahneman, D., Krueger, A., Schkade, D., Schwarz, N. and Stone, A. . Would you be happier if you were richer? A focusing illusion. Science, 2006, 312, 1908-1910.

Krumm J, Ubiquitous Computing Fundamentals. Boca Raton, FL: Chapman & Hall/CRC Press; 2009.

Langer T, Fox CR. Bias in allocation among risky and uncertain prospects: Partition-dependence, unit-dependence, and procedure-dependence. Working paper, University of Muenster.

Larrick, R. P., & Soll, J. B. (). The MPG illusion. Science, 2008, 320, 1593-1594

Levav J, Heitmann M, Herrmann A, Iyengar S. Order in Product Customization Decisions: Evidence from Field Experiments. Journal of Political Economy. 2010; 118 (2):274-299.

Loewenstein GF, Prelec D. Preferences for sequences ofoutcomes. Psychological Review. 1993;100: 91–108.

Madrian BC, Shea DF. The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior. Quarterly Journal of Economics. 2001;116(4):1149-1187.

Mandel N, Johnson EJ. When Web pages influence choice: Effects of visual primes on experts and novices. Journal of Consumer Research. 2002; 29(2):235-45.

Martin JM, Norton MI. Shaping online consumer choice by partitioning the web. Psychology & Marketing. 2009;26: 908-926.

Messick DM. Equality as a decision heuristic. In: Mellers BA, Baron J, eds. Psychological perspectives on justice: Theory and applications. New York: Cambridge University Press; 1993:11–31.

Murray KB, Liang J, Häubl G. ACT 2.0: The Next Generation of Assistive Consumer Technology Research. Internet Research. 2010;20(3):232-254.

Mytton O, Gray A, Rayner M, Rutter H. Could targeted food taxes improve health? Journal of Epidemiology and Community Health. 2007;61:689-694.

Nisbett, R.E. and Kanouse, D.E. . "Obesity, hunger, and supermarket shopping behavior." Proceedings of the American Psychological Association Annual Convention 1968.

Payne JW. Task Complexity and Contingent Processing in Decision Making: An Information Search and Protocol Analysis. *Organizational Behavior and Human Performance*. 1976;16(2):366-387.

Payne JW, Bettman JR, Johnson EJ. The Adaptive Decision Maker. Cambridge: Cambridge University Press. 1993.

Price B, Greiner R, Häubl G, Flatt A. Automatic Construction of Personalized Customer Interfaces. *Proceedings of the 11th International Conference on Intelligent User Interfaces (IUI-06)*. 2006; 250-256.

Read D, Loewenstein G. Diversification bias: Explaining the discrepancy in variety seeking between combined and separated choices. *Journal of Experimental Psychology: Applied.* 1995;1:34–49.

Reed A, Mikels JA, Simon KI. Older adults prefer less choice than young adults. *Psychology and Aging.* 2008;23:671-675.

Rosenfield DB, Shapiro RD, Butler DA. Optimal Strategies for Selling an Asset. *Management Science.* 1983;29(9):1051-1061.

Samuelson W, Zeckhauser R. Status Quo Bias in Decision Making. Journal of Risk and Uncertainty. 1998;1(1):7-59.

Scheibehenne B, Greifeneder R, Todd PM. Can there ever be too many options? A meta-analytic review of choice overload. *Journal of Consumer Research.* 2010;37: 409-425.

Schwartz ND. Bank of America Reports $7.3 Billion Loss, Citing Charges. In *The New York Times*. 2010.

Simonson I. The effect of purchase quantity and timing on variety-seeking behavior. *Journal of Marketing Research.* 1990;32:150–162.

Smith NC, Goldstein DG, Johnson EJ. Choice without Awareness: Ethical and Policy Implications of Defaults. Working paper. 2010.

Streitz N, Kameas A, Mavrommati I. *The Disappearing Computer: Interaction Design, System Infrastructures and Applications for Smart Environments*, Heidelberg: Springer. 2007.

Sunstein CR, Thaler RH. Libertarian Paternalism Is Not an Oxymoron. *The University of Chicago Law Review*. 2009;70(4):1159-1202.

Thaler R, Kahneman D, Knetsch JL. The Endowment Effect, Loss Aversion and Status Quo Bias. In: Thaler R, The Winner's Curse, Princeton: Princeton University Press, 1992 63-78.

Thaler, RH, and Sunstein, CR. *Nudge: Improving Decisions about Health, Wealth and Happiness,* 2008, New Haven: Yale University Press.

Vilsack T. (2010) Obama Administration's Priorities to Improve National School Lunch and Breakfast Programs, Speech at the National Press Club, February 23, 2010.

Wansink B, Just DR, Payne CR. Mindless Eating and Healthy Heuristics for the Irrational. *American Economic Review.* 2009; 99(2):165 – 169.

Wansink B, Sobal J. Mindless Eating: The 200 Daily Food Decisions We Overlook. *Environment and Behavior*. 2007;39(1):106-23.

Weber M, Eisenführ F, Von Winterfeldt D. The Effect of splitting attributes in multiattribute utility measurement. *Management Science*. 1998;34:431–445.

Weitzman M. Optimal Search for the Best Alternative. *Econometrica*. 1979;47(3): 641-654.

Xiao B, Benbasat I. E-Commerce Product Recommendation Agents: Use, Characteristics, and Impact. *MIS Quarterly*. 2007;31(1):137-209.

Zwick R, Rapoport A, King A, Lo C, Muthukrishnan AV. Consumer Search: Not Enough Or Too Much? *Marketing Science*. 2003;22(4):503-519.