# Cognitive biases, heuristics and decision-making in design for behaviour change

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**Abstract**

Much human behaviour can be seen as *decision-making*, and so understanding and influencing those decision-making processes could be an important component in design for behaviour change. This paper examines the 'heuristics and biases' approach to modelling decision-making, and attempts to extract insights which are relevant to designers working to influence user behaviour for social or environmental benefit—either by exploiting biases, or helping to counter those which lead to undesirable behaviour. Areas covered include a number of specific cognitive biases in detail, and the alternative perspective of Gigerenzer and others, who contend (following Herbert Simon) that many heuristics potentially leading to biases are actually ecologically rational, and part of humans' adaptive responses to situations. The design relevance of this is briefly considered, and implications for designers are summarised.

## 1 Introduction

> "A useful theory of rational thinking... ought to provide advice to people that they can follow. It does no good to try to teach people by saying "Be correct!" or "Make good decisions!" That is like telling investors to buy low and sell high: This advice only tells people what their goals are, not how to achieve them. An appropriate response to such advice is, "Gee, thanks."
>
> Jonathan Baron, *Thinking and Deciding*, 2nd edition, 1994, p.36

Much human behaviour can be seen as *decision-making*, and so understanding and influencing those decision-making processes could be an important component in design for behaviour change. As Plous (1993, p.xv) notes, "more research has been published on failures in decision making than on successes": decision-making research is often about deviations from what is assumed to be rational choice, whether these are framed as shortcomings in human reasoning, or as adaptive strategies. The area of decision-making research focused on understanding *heuristics and biases* (Tversky and Kahneman, 1974) arose in particular from studying people's judgement under conditions of uncertainty, such as common subjective assessments of probability, but because of the wider societal implications of the effects uncovered, the study has since developed into fields such as behavioural economics and, in recent years, gained significant political attention.

What is a cognitive bias? It is assumed to be, essentially, a systematic bias in the outcomes of decisions people make, arising from the application of one or more heuristics[1]: "rules of thumb" (Thaler and Sunstein, 2008, p.22) or "inference mechanisms" (Gigerenzer et al, 1999, p.vii)—simple 'shortcut' strategies for making decisions or judgements. For example, if we are in an unfamiliar city in the evening, looking for somewhere to eat, a quick heuristic might be to go for a restaurant that looks popular, while a more detailed heuristic might involve looking up information on the different restaurants in the city and comparing relative distances, prices, and so on.

A number of heuristics involve *attribute substitution* of one form or another; "When confronted with a difficult question people often answer an easier one instead, usually without being aware of the substitution... A professor who has heard a candidate's job talk and now considers the question 'How likely is it that this candidate could be tenured in our department?' may answer the much easier question: 'How impressive was the talk?'... We will say that judgment is mediated by a heuristic when an individual assesses a specified target attribute of a judgment object by substituting another property of that object—the heuristic attribute—which comes more readily to mind" (Kahneman and Frederick, 2002, p.53).

## 2 Two cognitive systems

Some common heuristics and biases with relevance to design for behaviour change are outlined below, but first it is worthwhile examining the concept of the 'two cognitive systems'. Much current cognitive psychology research assumes a 'dual process model' of brain functions (e.g. Chaiken and Trope, 1999; Sloman, 2002): there are held to be two 'systems' at work when we make decisions, the purpose of the labelling from psychologists' perspective being to "distinguish cognitive operations that are quick and associative from others that are slow and rule-governed" (Kahneman and Frederick, 2002).

The way the two systems are characterised differs somewhat between researchers, but Evans (2008) notes that "[a]lmost all authors agree on a distinction between processes that are unconscious, rapid, automatic and high capacity, and those that are conscious, slow and deliberative." Stanovich and West (2002, p.436) call the two systems *System 1* and *System 2*; Kahneman and Frederick (2002) suggest the terms *Intuitive system* and *Reflective system* for Systems 1 and 2 respectively, while Thaler and Sunstein (2008) use *Automatic* and *Reflective*. Other terminology is also available (Evans, 2008).

In Kahneman and Frederick's explanation (2002, p.51), "System 1 quickly proposes intuitive answers to judgment problems as they arise, and System 2 monitors the quality of those proposals, which it may endorse, correct, or override. The judgments that are eventually expressed are called intuitive if they retain the hypothesized initial proposal without much modification." The distinction between System 1 and System 2 also seems to have significant parallels with Petty and Cacioppo's peripheral and central route persuasion (1981; see Lockton, 2012a for its relevance to design). Sloman (2002, p.380-3) suggests analogies with different kinds of computational principles: "Roughly, one system [1] is associative and its computations reflect similarity and temporal structure; the other system [2] is symbolic and its computations reflect a rule structure... When a response is produced solely by the associative system [1], we are conscious only of the result of the computation, not the process. In contrast, we are aware of both the result and the process in a rule-based computation [2]."

Thaler and Sunstein (2008, p.23) characterise heuristics and biases as "emerg[ing] from the interplay between the Automatic System and the Reflective System"—essentially, they arise when the Reflective

[1]The wider definition of heuristics as "methods that are sometimes useful in solving a problem—useful enough to try even when it is not clear that they will help" (Baron, 1994, p.70) derives from Pólya's (1945) *How to Solve It*, a handbook of mathematical techniques which will be discussed further (for its format, approach and relevance to design patterns) in a forthcoming working paper.

System (2) does not sufficiently adjust or correct erroneous intuitive judgments made by the Automatic System (1). Kahneman and Frederick (2002, p.59) offer a perhaps more nuanced view, suggesting that certain heuristics are deliberately employed by System 2, for example when unsure about a decision but needing to make one (perhaps quickly) and lacking prior knowledge or reasoning—e.g. "when a voter decides to evaluate candidates solely by their stance on a particular issue."

# 3 Design implications: exploiting and countering heuristics and biases

From a design point of view, at least at this stage, debate over the two systems probably does not matter too much: the question is about what can be usefully learned from studies on heuristics and biases in terms of *practical application in influencing user behaviour*. The question of where heuristics, biases and cognitive systems fit into designers' models of how people think and behave has been addressed in Lockton, Harrison and Stanton (2012) via a study with a group of designers; of the three models proposed there, one, the *shortcut user*, attempts to cover all shortcut-type heuristics and biases, whether deliberately employed by users or not.

The next sections will outline a few of the cognitive biases and heuristics that have been 'discovered', and their potential relevance to, or application in, design for behaviour change. It does not seem essential to distinguish between heuristics and biases themselves from a design point of view: they are either effects which may be useful for design because they could be exploited to influence people's behaviour, or important because there is an opportunity to counter them to help people make better decisions (e.g. Nisbett et al, 1982; Fischhoff, 2002), hence influencing the desired behaviour. As Baron (1994, p. 47) notes, "[i]t is, in a way... a cause for optimism to discover biases and irrationalities, for we can teach people to avoid them." In some cases, both exploiting the bias and helping people to avoid it through design may be appropriate in different situations.

While much research on heuristics and biases has arisen from studies of estimating probability, for the designer this is not primarily the condition under which the effects will be used or countered: situated interaction decisions (Suchman, 1987/2007) can make use of heuristics without assuming that the user is assigning probabilities to the value of different actions. In some cases, the designer's scope to improve decision processes may be simply about making functions and consequences 'transparent' to allow users to make more informed decisions: as Sloman (2002, p.380) notes, "[a] manipulation that reduces bias by making an extensional probabilistic or logical relation transparent is in essence providing a representation that affords rule-based inference, allowing people to go beyond associative reasoning."

## 3.1 Confirmation bias

One of the most fundamental biases identified is the *confirmation bias*: "potentially confirmatory evidence is apt to be taken at face value while potentially disconfirmatory evidence is subjected to highly critical and skeptical scrutiny" (Ross and Anderson, 1982, p.149). That is, people have a tendency to overweigh evidence that supports a point of view they already have, and not to search impartially for evidence that might cause them to change their mind (Baron, 1994).

A way to counter this (potentially through design) is to direct people to think of evidence against what they already believe, as part of a decision process—including some step where people are confronted with the suggestion that there might be other points of view or consequences to consider. Wilson et al (2002, p.197) suggest "asking people to 'consider the opposite,' whereby they imagine different outcomes than the ones they had been thinking about. Simply thinking about whether a specific hypothesis is true,

for example, increases people's beliefs in its validity because the person focuses more on explanations as to why it could be true than why it could be false".

## 3.2 Framing and loss aversion

Another fundamental concept is that of *framing*: the same situation, but presented, described or understood differently, can lead to different decisions being made. This may perhaps seem intuitively obvious to designers, who are used to the importance of presentation, but it is worth recognising framing effects as phenomena relevant to a variety of contexts, with the potential to be either exploited or corrected. For example, Slovic et al (1982, p.91) report that reframing the statistics about the number of injuries and deaths in road accidents from an 'incidents per million person-trips' frame to a per-person lifetime perspective (how likely an individual person is to be injured in a road accident over his or her life) led to people "respond[ing] more favorably toward seat belts (and air bags)." It is easy to imagine similar reframings of statistics around energy use, environmental impact, health-related behaviour, and so on, potentially via designed interfaces giving feedback on behaviour.

A relatively simple reframing of the way the information is presented or thought about can affect the way people make decisions. Research on *mental accounting* (e.g. Thaler, 1999) suggests that, for example, framing money off as a rebate means it seems like a gift, whereas just reducing the price of product by the same amount is less attractive. Baron (1994, p.390) suggests that "by segregating outcomes at appropriate times, we can deceive each other—and even deceive ourselves—into thinking that we are getting more for our money. One simple principle here for a seller (including the person who wants to sell something to himself) is the motto *Segregate the gains, integrate the losses.* The late-night television advertisements for kitchen utensils offer a long list of (segregated) gains from buying the product, as does the car dealer who wants to add many options (for only a 'small' additional cost)."[2]

Much of the research in this area emerged from trying to understand *loss aversion*, people's tendency to prefer to take risks to avoid a loss, but avoiding risks to obtain a gain. Kahneman and Tversky's prospect theory (1979) sought to explain how people deviate from the conventional economic expected-utility model: the same quantity is valued as having greater magnitude when framed as a loss than when framed as a gain. For example, if offered choice A: 'an 80% chance of £4,000, a 20% chance of nothing' or choice B: 'a 100% chance of £3,000', more people choose B, the 'certain' outcome (80% of participants for this particular example in Kahneman and Tversky's study—using Israeli pounds) even though the expected utility of A is £3,200 (i.e. 80% of £4,000) compared with B's £3,000.

Thaler (1980, p.45) notes that credit card company lobbyists in the US pressured retailers to frame "any difference between [prices charged to] cash and credit card customers... [in] the form of a cash discount rather than a credit card surcharge. This preference makes sense if consumers would view the cash discount as an opportunity cost of using the credit card but the surcharge as an out-of-pocket cost." As Baron (1994, p.363) puts it, "by manipulating the reference point, we can make a subjective gain into a subjective loss and vice versa."

### 3.2.1 Anchoring and arbitrary coherence

Numbers—especially prices—and products themselves can act as *anchors*, setting reference points for what people expect to pay (or, potentially, how people expect to behave in general). Certain choices can also be deliberate *decoys*, not intended to be chosen, but solely included to make the other choices look more attractive in comparison,

[2] Poundstone (2010, p.15) notes that: "When Amos Tversky received a MacArthur grant in 1984, he joked that his work had established what was long known to 'advertisers and used-car salesmen.'"

Ariely et al (2003) demonstrated an additional aspect of anchoring, which they term arbitrary coherence—"although initial prices... are 'arbitrary', once those prices are established in our minds they will shape not only present prices but also future prices (this makes them 'coherent')" (Ariely, 2008, p.26). In the study, each participant was asked to write down the last two digits of his or her social security number (from 00 to 99), and then 'bid' on various products (wine, a cordless keyboard, some chocolates, etc). The results showed that participants with the highest-ending social security number digits bid significantly higher than participants with lower numbers. "[S]tudents with social security numbers ending in the upper 20 percent placed bids that were 216 to 343 percent higher than those of the students with social security numbers ending in the lowest 20 percent" (Ariely, 2008, p.28).

The size labels used by coffee shops such as Starbucks have been cited as designed to be strategically framed (e.g. Everything2.com discussion, 2001-5): Starbucks' menu starts with a 'Tall' as its smallest size, shifting the reference point for comparing sizes. The suggestion is that framing the size range 'up' the scale avoids 'mediocre' implications for any of the sizes, and avoids suggesting a 'loss' for the smaller sizes. By starting with Tall, every larger size offers a 'gain'. Just (2011) has investigated aspects of this via a study in a university cafeteria, finding that size labels did not seem to influence people's willingness to pay in the way prospect theory might suggest, but that people do seem to use size labels as "objective information about the size of the portion—even though the food was clearly visible" (p.11).

### 3.2.2 Applications in design

Framing—or reframing—can be seen as covering a huge range of practices and techniques: anything which shifts people's reference points (including *anchoring* and *decoy effects*) or presents a situation or choices differently (Thaler and Sunstein's *choice architecture* (2008)). From the design for behaviour change perspective, it is probably worth considering reframing as an approach relevant to any situation where it is possible to elicit a different point of view or behaviour by restructuring the way information is presented, particularly if the reframing can take into account loss aversion.

In an environmental application, Yates and Aronson (1983, p.438) note that many "informational campaigns stressing the amount of money and energy that can be saved by investing in alternative energy sources and conservation devices encourage people to define this as a gain or win situation," but that taking loss aversion into account, "this labeling may function as a deterrent to the acceptance of the new technology or behavioural practice." They recommend a reframing—"[home energy] auditors should focus on showing residents how much they are losing every month by not investing in alternative energy sources and conservation measures... People may not go out of their way to save money, but it appears that they are willing to act to avoid losing it."[3]

Following this argument, framing a suggestion of closing the office blinds or curtains at night before going home as "Every bit of heat lost means a smaller bonus this year!" is perhaps more likely to be effective than "Close the curtains and have a larger bonus!" Equally, where a system can give users feedback it makes sense, if possible, to frame this in terms which are known to have most impact on particular users—if it is known that a certain group of users cares more about money than about the environment, frame the feedback in terms of financial costs, whereas for others, feedback framed in terms of environmental impact (or social benefit) might be more appropriate. User segmentation may be relevant here in terms of deciding which way to frame the feedback.

[3] A comparison of the effectiveness of framing energy use behaviour change as being about *avoiding wasting energy* rather than *saving energy* is something the author intends to pursue in a future study.

## 3.3 Status quo bias, defaults, opt-ins and opt-outs

> "[I]f, for a given choice, there is a default option—an option that will obtain if the chooser does nothing—then we can expect a large number of people to end up with that option, whether or not it is good for them."
>
> Richard Thaler and Cass Sunstein, *Nudge*, 2008, p.84

There is an asymmetry between the 'present state' in any situation, and a change in behaviour: the present state, the *status quo*, is more likely to be taken as the reference point (Samuelson and Zeckhauser, 1988), and deviations from this regarded as riskier, less desirable, or simply too much effort. Whether defaults are consciously designed into systems—from interfaces to pension schemes—or "established via historical precedent, perceptual salience, conspicuousness, or some other feature that qualitatively distinguishes one option from the rest" (Frederick, 2002, p.555), their existence can lead to a bias towards *omission* (as opposed to *commission*), not changing behaviour (or not doing anything at all). Frederick (2002) suggests that even if not planned as a 'status quo' option, defaults can arise simply as 'focal points' in a system, using Schelling's (1960) concept.

### 3.3.1 The power of defaults

Kesan and Shah (2006, p.587) examine the importance of defaults in software, from a legal perspective as well as a behavioural economic one. They give the example of the default home page of the Netscape browser, in the context of AOL's $4.2 billion acquisition of Netscape in 1998: "the most valuable part of Netscape was not its software, but its default setting for its home page. Because a large number of users (estimated at forty percent) never changed this default setting, Netscape's home page had enormous popularity."[4] Shah and Sandvig (2005), in a survey of 375,000 wireless routers in the US, found that "when a manufacturer sets a default setting [such as encryption settings] this produces 96-99% compliance"—something which potentially has legal implications where unencrypted wireless access is 'open' by default, yet the router owner may be found liable for any illegal activity committed by others using the access point.

The implication here is not only that people stick with default settings, but that *they may not even realise that they are settings at all*: they are presented to the user as a fait accompli. "If a person does not know about the possibility of changing an option or the ramifications of each choice, then a default setting is equivalent to a fixed setting" (Kesan and Shah, 2006, p.601).

Apple's *Human Interface Guidelines* (Apple, 2009, p.241), as used to define the design of application graphical user interfaces by developers writing for Mac OS X, specifically recommend a very cautious approach to using defaults:

> "Usually the rightmost button or the Cancel button is the default button. The default button should be the button that represents the action that the user is most likely to perform if that action isn't potentially dangerous. A default button has color and pulses to let the user know that it is the default. When the user presses the Enter key or the Return key, your application should respond as if the user clicked the default button.
>
> Don't use a default button if the most likely action is dangerous—for example, if it causes a loss of user data. When there is no default button, pressing Return or Enter has no effect; the user must explicitly click a button. This guideline protects users from accidentally damaging

[4] With similar reasoning, from 2011—2014, Google is paying the Mozilla Foundation around $300 million a year in royalties for Google to be the default search engine in the Firefox browser (Swisher, 2011).

their work by pressing Return or Enter. You can consider using a safe default button, such as Cancel."

This last point—the "user must explicitly click a button" recommendation—is paralleled by Thaler and Sunstein's (2008) concept of 'required choice' or 'mandated choice': removing defaults entirely to make sure that someone actively chooses something rather than simply going with the default. Thaler and Sunstein's recommendations on using a mandated choice question on organ donation on driving licence renewal forms (2008, p.180)—the question would have to be answered and could not be skipped—appear to have been adopted in a modified form by the UK's Driver and Vehicle Licensing Authority (BBC News, 31 December 2010), under the slightly friendlier title of 'prompted choice'. Baron (1994, p.507) suggests "ask[ing] what would be chosen if there were no status quo," i.e. prompting people to think about what they would choose to do if there were no default or existing pattern of behaviour.

### 3.3.2 Opt-ins and opt-outs

Johnson and Goldstein (2003) also examined the effects of defaults (and framing) on organ donation, in particular the concept of presumed consent, and the notion of opt-ins and opt-outs. In countries with presumed consent for organ donation, such as Austria and France, the default is that organs are donated: someone must explicitly opt out of the scheme. In Austria, just 0.02 percent of the population chooses to opt out. In other countries such as the UK and Denmark, explicit consent is required: someone must opt-in to the scheme, the default being that organs are not donated. In Denmark, only 4.25 percent of the population chooses to opt in (the UK figure is around 17 percent).

Indeed, in Germany, an opt-in country, only 12 percent opt in, compared with 99.98 percent across the border in Austria. Johnson and Goldstein ran an online study asking respondents whether they would agree to be donors on the basis of one of three different conditions—opt-in, opt-out and a 'neutral' condition with no default. "In the opt-in condition, participants were told to assume that they had just moved to a new state where the default was not to be an organ donor, and they were given a choice to confirm or change that status. The opt-out condition was identical, except the default was to be a donor. The third, neutral condition simply required them to choose with no prior default." (Johnson and Goldstein, 2003, p.1338). The study found that donation rates for the opt-out condition (82 percent) were nearly twice those for the opt-in condition (42 percent), while the neutral condition produced almost identical results to the opt-out condition (79 percent).

Baron (1994, p.389) suggests an additional angle on the opt-in/out issue: framing the choice as being about *choosing* or *rejecting* options, in order to "manipulate attention to positive and negative features... We tend to choose options because of their positive features but reject them because of their negative features."

### 3.3.3 How to use defaults

Goldstein et al (2008, p.102) offer a 'decision tree for setting defaults', published in the Harvard Business Review. The idea is to "help companies design defaults that align with customers' preferences and support good decisions," making use of a number of categories of defaults with different characteristics. The basic distinction is between 'personalised defaults' (where defaults can be tailored to individual customers or users), and 'mass defaults' (where they cannot). The sub-categories of mass defaults are: *hidden options* (where a single choice is presented as not just the default, but the only option); *benign defaults* (a kind of 'best guess' default acceptable to most customers); *forced choice* (Thaler and Sunstein's mandated choice—see above); and *random defaults* (where customers are assigned different defaults randomly).

Goldstein et al note that "The U.S. government... relied on random defaults in assigning senior citizens to one of many prescription drug plans. That default strategy had its critics, but others like it can be useful when an organisation lacks information about individual or majority preferences, feels that none of the configuration options is the clear benign choice, and believes that none would cause harm" (p.103). In the personalised defaults branch, the sub-categories are: persistent defaults (based on knowing a customer's past preferences; smart defaults (based on demographic or market segmentation data); and adaptive defaults (based on real-time usage decisions). Each category has advantages and disadvantages in different contexts; while focused on business contexts, the decision tree potentially offers a useful guide for designers too.

People will often choose whatever option is easiest, or looks correct, and so careful redesign of choices to make the most efficient one the default has the potential to be effective. McCalley (2006) removed the default temperature settings from a washing machine interface, giving users 0°C as a new starting point, and found a 24% reduction in electricity use over 20 washing trials compared with a control group using the manufacturer's pre-programmed settings. If the options are available, and easy for users to select, it is more likely that they will be used. Where energy-using appliances have multiple possible energy use modes or settings (e.g. a refrigerator with adjustable temperature, or a washing machine with a number of different wash cycles), the system could default to the mode which uses the least energy, and thus require users to make an explicit choice to deviate from this.

Depending on the complexity of the system, a context-based approach may be more appropriate, to reduce the likelihood of a too-low setting (e.g. a short 30°C wash cycle applied to heavily stained clothes) giving poor results, leading to frustration. If there is no default mode, simply making the least energy mode more prominent or easy to select is an alternative that can be accomplished simply by redesigning the user interface (equally, making energy-intensive modes more difficult to select may achieve the same result). Devices where unnecessary (excessive) energy and water use are very common, such as electric kettles, could require users to make a choice about the amount of water that needs to be heated before starting, as on the Eco Kettle (Product Creation Ltd., n.d.) or heat only one unit quantity at a time, as on the Tefal QuickCup (Tefal UK Ltd., n.d.) .

One problem with attempts to encourage people to change default settings or actively make choices where previously they did not have to is the risk that if it 'goes wrong', the effects will be felt more (a corollary of loss aversion). Kahneman and Miller (1986, p.354-5) propose "a hypothesis of emotional amplification that states that the affective response to an event is enhanced if its causes are abnormal... the same undesirable outcome is judged to be more upsetting when the action that led to it was exceptional than when it was routine."

## 3.4 Salience biases and the availability heuristic

*Salience biases* derive from findings that "colorful, dynamic, or other distinctive stimuli disproportionately engage attention and accordingly disproportionately affect judgments" (Taylor, 1982, p.192). This is perhaps intuitively true to designers, at least in terms of engaging attention. Explicit applications of colours for this purpose are numerous, but other dynamic stimuli have also been used, such as Ju and Sirkin's (2010) study using an information kiosk with a physical waving hand, gesturing to passers-by to interact with the kiosk. The waving hand influenced twice as many people to interact with the kiosk as did an on-screen animation of a waving hand. While it would be possible to see a novelty effect at work here, the technique was effective in the intended context.

The *availability heuristic* (Tversky and Kahneman, 1974) deals with how people's estimates of the probability of an event (or the size of a class) are influenced by how easily characteristics or examples come to mind (how 'available' they are). "For example, one may assess the divorce rate in a given

community by recalling divorces among one's acquaintances... and one may estimate the probability that a violent person will 'see' beasts of prey in a Rorschach card by assessing the strength of association between violence and beasts of prey" (Tversky and Kahneman, 1973, p.164). Salience is considered as an important factor in establishing availability: "the impact of seeing a house burning on the subjective probability of such accidents is probably greater than the impact of reading about a fire in the local paper" (Tversky and Kahneman, 1974, p.11). The implication for designers is that if we want an idea (or the idea of a behaviour) to be 'available' for people to consider (not just in a probability sense, but in terms of familiarity), making it salient in some way is a sensible step.

### 3.4.1 Applications of salience to influencing more sustainable behaviour

Salience and the availability heuristic probably have some effect on people's estimation of the energy used by different everyday systems, and the behaviour changes they believe are worthwhile making. For example, a major survey by Attari et al (2010) found that "most participants mentioned curtailment (e.g., turning off lights, driving less) rather than efficiency improvements (e.g., installing more efficient light bulbs and appliances)" as the most effective strategies they could think of for saving energy; the energy used by equipment where energy use is 'invisible', such as air conditioners, space heaters and clothes dryers was underestimated, while the energy used in lighting—a 'visible' context—was more accurately estimated.

Without thinking or understanding too much about energy use, people overestimate the energy used by some appliances where it is very visible (e.g. lighting) compared with invisible uses such as air conditioning (Kempton & Montgomery 1982, cited in Lutzenhiser 1993). This immediately suggests redesigning devices to incorporate obvious, vivid displays of energy use: increasing the salience of energy use in contexts where it is currently lacking. This could be feedback on actual energy use (see Lockton, 2012b) or simply a reminder that energy is being used—an ultra-simple kind of feedback.

A series of innovative projects from the Interactive Institute in Sweden (e.g. Mazé and Redström, 2008) have focused on exactly this salience aspect: increasing awareness of energy use by displaying it vividly and memorably, for example: the Power Aware cord (Gustafsson and Gyllenswärd, 2005), a load-proportionally illuminated electrical extension lead where "the intention was to make a user, to some extent, perceive the light as the actual electricity" (Backlund et al, 2006, p.7); the Element (Backlund et al, 2006), a 2kW electric heater using an array of 60W incandescent light bulbs to display very vividly the energy used; and the Energy AWARE Clock (Broms, 2011, p.35-6), which "visualizes the daily electricity rhythms of the household" by drawing around a 24-hour clock face—"a new kind of energy display that would borrow the connotations of a normal kitchen clock—glanced at regularly throughout the day—in order to make electricity use more concrete in relation to ordinary activities as well as to be a tool that can encourage discussions about electricity consumption in the home." A number of these projects go further than increasing general awareness of energy use into providing new kinds of more vivid feedback beyond simply numbers and conventional graphs.

It could be that a display 'translates' all environmental impact into some single vivid shortcut 'measure' which is intended to have an emotional impact on users, such as Shiraishi et al's EcoIsland game (2009), which "visualises the user's current eco-friendly behaviour as an island shared by his/her family members," with the island sinking (apparently a powerful metaphor in Japan) if the family does not work together to reduce their $CO_2$ impact. A trial with six families led to increases in environmental awareness but not significant changes in actual behaviour. In this context, Wilson & Dowlatabadi (2007) note that "emphasising one particularly salient or emotional attribute may influence a decision more than providing information on all attributes."

Dillahunt et al (2008) similarly used an emotionally engaging Flash-based 'virtual polar bear' standing

on a shrinking (or growing) ice floe to represent the total effects of participants' (self-reported) environmentally responsible behaviour (selected from a list of commitments); the number of commitments fulfilled by participants who interacted with the polar bear was greater than for a control group.

There is certainly a risk here of oversimplification, of conflating unrelated environmental behaviours and impacts into a 'measure' which is nothing of the sort, without educating users about anything deeper, but it may be that a highly salient, perhaps emotionally engaging shortcut can be appropriate for some users, along the lines of Tamagotchi and other virtual pets.

## 3.5 Serial position effects

*Serial position effects* describe biases where a person overweighs or underweighs evidence based on the order in which it is presented. As Baron (1994, p.283) notes, "[w]hen the order in which we encounter two pieces of evidence is not itself informative, the order of the two pieces of evidence should have no effect on our final strength of belief. Or, put more crudely, 'When the order doesn't matter, the order shouldn't matter.'" Nevertheless, order can matter. *Primacy effects* (the earlier a piece of information is presented, the more influential it is) and *recency effects* (the more recently a piece of information is presented, the more influential it is) have both been demonstrated (e.g. Asch, 1946; Murdock, 1962).

### 3.5.1 Primacy

Asch's investigation of what he called "the factor of direction" involved reading to participants two lists of adjectives describing a man, and then asking them for an evaluation of his personality; the two lists comprised the same words, but in reverse order. So one list started with intelligent and ended with envious, while the other started with envious and ended with intelligent. Comparing the personality assessments—even when written by the same participants—showed a tendency for the earlier adjectives in each list to dominate the assessment. "The accounts of the subjects suggest that the first terms set up in most subjects a direction which then exerts a continuous effect on the latter terms. When the subject hears the first term, a broad, uncrystallized but directed impression is born. .The next characteristic comes not as a separate item, but is related to the established direction. Quickly the view formed acquires a certain stability, so that later characteristics are fitted—if conditions permit—to the given direction" (Asch, 1946, p.271-2).

Baron (1994, p.285) suggests that this kind of primacy effect may involve people (unwittingly or otherwise) making "some commitment to the belief suggested by the earliest evidence they receive. If they simply note the evidence and its implications, without forming a desire that its implications be true, they may remain open-minded until all of the evidence is in."

Some design-relevant research on the effect of ordering candidates on ballot papers has suggested a strong primacy effect, e.g. Koppell and Steen (2004, p.267), who found that "[i]n 71 of 79 individual nominating contests [for the 1998 Democratic primary in New York City], candidates received a greater proportion of the vote when listed first than when listed in any other position. In seven of those 71 contests the advantage to first position exceeded the winner's margin of victory, suggesting that ballot position would have determined the election outcomes if one candidate had held the top spot in all precincts."

### 3.5.2 Recency

Recency effects are more generally associated with information still being held in people's short-term working memory; Miller and Campbell (1959) compared the two effects via ordering sections of some court proceedings (arguments for the plaintiff, and arguments for the defence) in eight different ways, including

introducing delays between arguments and/or after both arguments had been presented. The conclusions suggest that when arguments are presented one after the other, and then there is a delay before their evaluation, the primacy effect dominates—the earlier argument is weighed more highly—while when there is a delay between arguments being presented, and then the evaluation occurs straight after the second argument, the recency effect dominates—the later argument is weighed more highly. As Plous (1993, p.44) points out, this suggests that "[i]f you are offered the choice of speaking first or last in a public debate, you should speak first if the other side will follow you immediately and there will be a delay between the debate and people's responses to it... On the other hand, if some time will separate the two communications, and people will be asked to act immediately after the second presentation, you should capitalize on the recency effect and choose to go last."

The implications for design can be relatively straightforward: Lidwell et al (2003, p.178) suggest that designers should "[p]resent important items at the beginning or end of a list (versus the middle) in order to maximize recall." A debiasing strategy from a design point of view might be to randomise the order in which choices are presented, as Microsoft was required to do by the EU Competition Commissioner in 2009 with the choice of web browsers offered to users to settle an anti-trust suit (Wauters, 2010).

### 3.6 Cialdini's 'weapons of influence'

Robert Cialdini (1984/2007) offers a set of six 'weapons of influence'—techniques for influencing behaviour—distilled from heuristics and biases research, other areas of psychology, and Cialdini's own experiences (he spent three years "observ[ing], from the inside, the techniques and strategies most commonly and effectively used by a broad range of compliance practitioners" (2007, p.xii) such as salespeople, fund-raisers and advertisers).

Each of Cialdini's 'weapons' is explained via practical examples, from Tupperware parties to used-car sales, and is offered both as a technique for potential *use* in business or personal life by the reader, and as something of an education in persuasion literacy, to help the reader become more familiar with techniques which he or she may experience when others are trying to exert behavioural influence. The practical nature of the techniques makes them eminently easily applicable in design contexts, as summarised in Table 1, and evinced by Cialdini's role as Chief Scientist to the energy billing innovation startup Opower. As such, patterns based on them could form a good core for an inspiration guide dealing with heuristics and biases.

## 4 An alternative perspective: ecological rationality

> "Casual observation suggests that people's judgment is generally 'good enough' to let them make it through life without getting into too much trouble"
>
> Baruch Fischhoff, 'Debiasing', in Kahneman, D., Slovic, P. & Tversky, A. (eds.), *Judgment Under Uncertainty: Heuristics and biases*, 1982, p.422
>
> "The best kind of thinking, which we shall call rational thinking, is whatever kind of thinking best helps people achieve their goals"
>
> Jonathan Baron, *Thinking and Deciding*, 2nd edition, 1994, p.29

Following the discussion of cognitive biases and heuristics, it is important to consider an alternative perspective on rationality and behaviour. The behavioural economics perspective developed by Tversky and Kahneman (1974), Thaler and Sunstein (2008) and others is often characterised as presenting humans as essentially flawed, less-than-rational creatures whose cognitive biases lead us into sub-optimal behaviour,

Table 1: Cialdini's (2007) six 'weapons of influence', with possible design implications.

| TECHNIQUE | DESCRIPTION | POSSIBLE DESIGN IMPLICATIONS |
|---|---|---|
| Reciprocation | People feel indebted—obliged to reciprocate in some way—when someone appears to do them a favour, even if they did not ask for the favour in the first place. Cialdini (2007, p.22-24) discusses the Hare Krishna fundraising tactic of pressing 'gifts' such as a book or a flower into the hands of passersby, with the aim of provoking a reciprocal response such as a donation. | If designing systems which depend on sharing, or will work better if users contribute, design the interface to encourage reciprocation. Give users something up-front, perhaps unexpectedly. Can involve 'guilting' the user, but is best if the user genuinely wants to return a favour. Example: Azureus (now Vuze), a BitTorrent client, encourages users to 'reciprocate' for having downloaded a file by continuing to seed it. |
| Commitment & consistency | Explained either by cognitive dissonance or self-perception theory (see Lockton 2012a for relevance to design), the commitment & consistency bias describes people's "nearly obsessive desire to be (and to appear) consistent with what we have already done" (Cialdini, 2007, p.57). This can be exploited via 'foot in the door' techniques which gradually escalate small commitments into much larger behaviours. | Design your system to get users to commit in some way to an idea or goal (perhaps a small one initially) as part of a process; they are then more likely to behave in accordance with this to appear or feel 'consistent'. Example: Voluntarily choosing to have a water meter installed can demonstrate some commitment to reducing water, which may persist as a household tries to remain consistent with the commitment. |
| Social proof | See forthcoming working paper on social factors in design for behaviour change | |
| Liking | People are more likely to be persuaded or influenced by people that they like. "Despite the entertaining and persuasive salesmanship of the Tupperware demonstrator, the true request to purchase the product does not come from this stranger; it comes from a friend to every woman in the room... [Customers] buy from and for a friend rather than an unknown salesperson" (Cialdini, 2007, p.168). | Make use of people's friends or figures and personalities that they like to deliver persuasive messages, or cultivate a product or brand personality which is likeable and friendly in order to influence users to behave in the ways suggested. See also Carnegie (1936/1981) and coverage of affective and emotional design in Lockton (2012a). |
| Authority | Using famous experiments such as the Milgram obedience studies, Cialdini discusses the use of 'appeals to authority' as a method of persuasion, in contexts ranging from celebrity endorsement of products (e.g. the "I'm not a doctor, but I play one on TV" line (TV Tropes, 2011)) to the use of clothes (e.g. a security guard's uniform) to trigger 'compliance' with requests. | Many users will behave as suggested by an 'authority figure' or expert even if that behaviour is outside what they would consider normal; systems can be designed to make use of this effect. Example: Much of Twitter's success at engaging users to join and participate was arguably due to well-publicised 'authority' figures and celebrities embracing it at an early stage. |
| Scarcity | The scarcity principle suggests that "opportunities seem more valuable to us when their availability is limited" (Cialdini, 2007, p.238). Whether scarcity is real or not in a situation, if it is perceived to be, people may value something more, and so alter their behaviour in response. | Design systems strategically to emphasise the scarcity of a resource. Make use of loss aversion (see section 3.2), or introduce artificial scarcity (e.g. digital rights management). Example: Digital fuel gauges showing the remaining range on the current tank can help concentrate drivers' minds on the scarcity value of the fuel. |

and therefore need to be 'fixed' (via government policy, or from a design point of view, via designed interventions).

From this perspective, the fact that humans are 'boundedly rational' (e.g. Simon, 1955, 1972) is a *defect* which often leads us to make bad decisions, for ourselves and for society, and needs to be cured, "treat[ing] deviations from well-defined, consistent preference functions as correctable faults. If individuals had deficient (i.e., inconsistent, incomplete) preference functions, they were to be induced to generate proper ones, perhaps through revealed preference techniques and education" (March, 1978, p.594).

## 4.1 Heuristics as adaptive responses to situations

However, Gigerenzer, Todd and others (Gigerenzer, 2008; Gigerenzer and Selten, 2001; Todd and Gigerenzer, 2012) have put forward the view, drawing more closely on Simon's original descriptions of bounded rationality, that our cognitive biases and the heuristics we use, including *satisficing* (Simon, 1956, 1969/1981), are in many cases *adaptive*—they are not sub-optimal, but actually very well optimised given the time and processing constraints humans face in everyday life contexts. As Slee (2006, p.27) puts it, choices are often our "best response" to the world and the actions of those around us.

Gigerenzer et al's (1999) 'Adaptive Toolbox' describes a kind of pattern library of *ecologically rational* 'fast and frugal heuristics' people use when faced with different situations which require a choice to be made.

For example, the *recognition heuristic* deals with situations where someone is asked to infer "which of two objects has a higher value on some criterion (e.g., which is faster, higher, stronger)." The heuristic is both fast and frugal to execute: simply, "[i]f one of two objects is recognized and the other is not, then infer that the recognized object has the higher value" (Goldstein and Gigerenzer, 1999, p.41). An example: a group of college students in the USA, asked whether Detroit or Milwaukee has a larger population, gave mixed answers, with only 60% choosing Detroit (the right answer). In Germany, however, students given the same question had mostly not heard of Milwaukee, but *had* heard of Detroit—thus by having *less* information, "a beneficial degree of ignorance" (Gigerenzer, 2008, p.7) they were able to make a more correct choice.

Gigerenzer's approach, by considering both 'blades' of Simon's scissors (Simon, 1990), treats decision-making as being determined both by cognitive processes and by the structure of the environment, and thus potentially has much to offer designers, particularly in understanding users' decision-making with products and interfaces. It is not difficult to imagine systems designed to make use of fast and frugal heuristics as part of a process of influencing behaviour—for example, the recognition heuristic would suggest that giving people a choice they recognise as being similar to something they already know could be a way of transitioning them to a desired new behaviour. Lockton, Harrison and Stanton (2012) explore some further aspects of this approach in the context of modelling user behaviour, while Lockton (2012c) develops the idea of uncovering and using 'behavioural heuristics' as part of the user research phase of design for behaviour change, modelling behaviour in terms of simple rules which could be matched to particular Design with Intent patterns (Lockton, Harrison and Stanton, 2010a, 2010b)

## 4.2 Habits as procedural rationality

Baron (1994, p.502-3) suggests that "[w]ithout realizing that we are doing so, we set precedents for ourselves... Practically every decision we make sets a precedent for the same decision in similar cases in the future. In this way, we form policies for the various domains of our lives. At times, of course, we think about these policies and change them. At any given time, however, we can be said to be following certain policies whether we have thought about them or not." This, then, is often how 'habits' arise.

Many behaviours relevant to environmental and social impact are the result of habits formed over time. Someone who gets into the habit of leaving a light on when leaving the room needs the new behaviour (turning it off) to become a habit replacing it. Darby (2006) notes that "as a rule of thumb, a new type of behaviour formed over a three-month period or longer seems likely to persist, but continued feedback is needed to help maintain the change and, in time, encourage other changes," citing a long-term (3-year) trial of "more informative energy bills" in Oslo by Wilhite & Ling (1995), who found that their improved bill design (with graphs comparing building users' energy use for the same months the previous year, corrected for temperature, and practical tips on energy saving) led to 10% reductions in energy use by the end of the third year.

In Wilhite & Ling's study, many participants who had reduced their energy use considerably were unable to give specific explanations of how they had done it, other than that their habits had changed: "When asked if they had done anything differently, very few respondents volunteered any specific changes until prompted by follow-up questions. Towards the end of the interviews, some people had remembered a change, usually which had to do either with lighting or space heating habits. Our impression from the interviews is that after three years the changes people made had become so routine that they had trouble identifying them." It seems clear, then, that a design intervention which can easily become a habit, or modify an existing everyday habit, could be effective.

Jackson (2005, p.36), referencing Simon (1957), notes that habits can be considered 'procedurally rational'—"cognitive scripts whose role is to reduce the cognitive effort required to make routine decisions whose rationality (i.e. optimality from the perspective of self-interest) has already been determined. For as long as these cognitive scripts serve the interests of rational decisions, they can in fact be regarded as rational habits." This adds an additional design perspective to the consideration of habits: if a designed system makes it easier for some actions to occur without imposing too much cognitive load, then it is probably more likely to be able to establish those actions as habits.

# 5 Implications for designers

- Much human behaviour can be seen as *decision-making*, and so understanding and influencing those decision-making processes could be an important component in design for behaviour change.
- A range of heuristics and biases have been identified; it is possible to see a 'design' application for many of them. It does not seem essential to distinguish between heuristics (which may cause the biases) and biases themselves from a design point of view: they are either effects useful for design because they could be *exploited* to influence people's behaviour, or because there is an opportunity to *counter* them to help people make better decisions, hence influencing the desired behaviour.
- Effects which may have significance for design include the confirmation bias, framing, the status quo bias (particularly in relation to defaults), salience biases and serial position effects. Cialdini's 'weapons of influence' are six cognitive bias-related strategies for influencing behaviour which are particularly easy to consider applying in a design context.
- Alternatively, or in parallel, 'fast and frugal' heuristics could be exploited via design: for example, the recognition heuristic would suggest that giving people a choice they recognise as being similar to something they already know could be a way of transitioning them to a desired new behaviour.
- Habits may arise over time simply through the precedent that one action sets for future ones. A design intervention which can easily become a habit, or modify an existing everyday habit, could be effective; equally, if a designed system makes it easier for some actions to occur without imposing

too much cognitive load, then it is probably more likely to be able to establish those actions as habits.

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