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Bounded rationality: the two cultures

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Research on bounded rationality has two cultures, which I call 'idealistic' and 'pragmatic'. Technically, the cultures differ on whether they (1) build models based on normative axioms or empirical facts, (2) assume that people's goal is to optimize or to satisfice, (3) do not or do model psychological processes, (4) let parameters vary freely or fix them, (5) aim at explanation or prediction and (6) test models from one or both cultures. Each culture tells a story about people's rationality. The story of the idealistic culture is frustrating, with people in principle being able to know what they should do, but in practice systematically failing to do it. This story makes one hide in books for intellectual solace or surrender to the designs of someone smarter. The story of the pragmatic culture is empowering: If people are educated to use the right tool in the right situation, they do well.

Keywords: bounded rationality; optimization; heuristics; stories; nudge; education

1. Introduction and outline

Bounded rationality does not speak with one voice. This is not only because bounded rationality is researched in various fields such as economics, psychology, engineering and management. Even within a single field such as economics, there are clear differences. For example, Selten (2001) rejects the optimization of a utility function as an expression of bounded rationality, contrary to the standard approach of behavioral economics as in bargaining games by Fehr and Schmidt (1999). There are multiple views of bounded rationality, as many authors including Rubinstein (1998) have pointed out.

The first contribution of this article is to analyze the formal modeling used to describe people's bounded rationality. At the risk of oversimplifying, I distinguish between two cultures, which I call 'idealistic' and 'pragmatic'. At a first approximation, the idealistic culture pursues a minimum departure from the neoclassical-economics framework of unbounded rationality, which assumes the ideals of omniscience and optimization of a utility function and adds factors such as inequity aversion or probability weighting to the utility function. On the other hand, the pragmatic culture holds that people sometimes ignore information and use simple rules of thumb in order to achieve satisfactory outcomes. A detailed discussion of the differences in modeling between the two cultures is provided in Section 2. The reality of the cultures and their differences is demonstrated by examples drawn from the literatures on risky choice and bargaining games. Note that it does not make sense to try to perfectly map specific researchers or programs of research to one or the other culture; for example, Amos Tversky worked on both cultures, with prospect theory being an idealistic model and elimination by aspects being a pragmatic model.

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Although the distinction between the idealistic and pragmatic cultures of bounded rationality can be criticized, as all binary distinctions can be, it provides food for thought and new insights. I aim at emulating Breiman's (2001) analysis of two cultures in statistics. Breiman argued that there exist two cultures that lead to two very different kinds of statistical theory and practice, proof-based and data-driven. Analogously, I argue in Section 3 that the idealistic and pragmatic cultures tell two very different stories about people's bounded rationality and how to improve it. This is the second contribution of this article. Echoing Morgan (2001), I conclude that these stories play a vital role in our understanding of the economic world and the economic policies we develop. I also venture outside economics and psychology to consider the idealistic and pragmatic cultures in engineering and management. I argue that the idealistic culture reigns in these fields, but at the same time the pragmatic culture is gaining momentum. Section 4 concludes the article.

2. The two cultures: differences in modeling

Table 1 presents six key modeling differences between the idealistic and pragmatic cultures of research on describing people's bounded rationality. This presentation is epigrammatic and oversimplified. The rest of the section spells out each difference, as well as their relationships.

In the following Section 2.1, I discuss the labels 'idealistic' and 'pragmatic', which are connected to the first difference in Table 1. In Section 2.2, I discuss the second and third differences in Table 1. The remaining differences in Table 1 are discussed in Section 2.3.

2.1. What do the labels 'idealistic' and 'pragmatic' mean?

The first difference between the two cultures refers to the building blocks they use in order to generate their models. This difference is the main reason for the labels 'idealistic' and 'pragmatic'. The idealistic culture of bounded rationality is indeed inspired by an ideal, unboundedly rational creature. This is a decision-maker who possesses all information that can possibly be gathered and, based on it, makes all possible correct deductions, which she uses to make an 'optimal' decision. For example, in a choice among risky gambles, this decision-maker knows all possible outcomes of each gamble, is able to assign a numerical utility to each outcome, knows the probability with which each outcome will occur

Table 1. Six key modeling differences between the idealistic and pragmatic cultures of research on describing people's bounded rationality.

Bounded-rationality cultures differences in modeling	Idealistic	Pragmatic
1. Building blocks, based on which models are generated	Logical axioms (e.g., people make transitive choices)	Empirical facts (e.g., people make choices based on only one reason)
2. Assumptions about people's goal	Optimization of a utility function	Achievement of a satisfactory outcome
3. Treatment of psychological processes	No models of processes; instead, as-if optimization	Models of processes as simple rules of thumb
4. Treatment of parameters	Let parameters vary freely	Fix parameters
5. Epistemic aim	Explanation of known facts	Prediction of new facts
6. Models tested	Only from idealistic culture	From both cultures

Note: The text in this section spells out each difference, as well as their relationships.

and finally calculates the expected utility of each gamble and chooses a gamble which obtains the maximum.

The choices of an expected utility optimizer can be represented by the logical axioms jointly equivalent to expected utility theory (von Neumann & Morgenstern, 1944). An example axiom is transitivity, where for all gambles x, y and z, if x is chosen over y and y is chosen over z, then x is chosen over z. According to some authors, such as Savage (1954), these axioms have normative status, meaning that a decision-maker should satisfy them.

The same kinds of axioms are the building blocks of the idealistic culture of bounded rationality. A researcher can generate new models of bounded rationality by retaining some axioms of unbounded rationality, taking out others and proposing new ones. For example, Kahneman and Tversky's (1979) prospect theory always satisfies transitivity but may violate independence (for all gambles x, y and z, and probabilities p, if x is chosen over y, then the compound gamble $[x, p; z, 1 - p]$ is chosen over $[y, p; z, 1 - p]$). Bounded-rationality models, such as prospect theory, have also been axiomatized by axioms that can be argued to be normative (Wakker & Tversky, 1993). Thus, the prospect-theory decision-maker is also ideal, just a bit less so than her expected utility ancestor.

But not everybody is happy with this industry of transforming neoclassical models to bounded-rationality ones. Güth called it a 'neoclassical repair shop' (1995, p. 342). Dissatisfaction and impatience with it runs through the whole volume edited by Selten and Gigerenzer (), who look away from axioms to find the building blocks of bounded rationality (Gigerenzer & Selten, 2001). They have the work of Herbert Simon – the father of bounded rationality – to fall back on, who, throughout his whole career, insisted on first considering what is known about how real people actually make decisions in the real world (Katsikopoulos & Lan, 2011). Tellingly, in the abstract of Simon's obituary, his longstanding colleague James March wrote: 'In particular, he persistently sought to clarify the real processes of human decision making …' (Augier & March, 2002, p. 1).

I call 'pragmatic' the culture that uses empirical facts as its building blocks. As an example of a model of the pragmatic culture, take the priority heuristic for choices among risky gambles (Brandstätter, Gigerenzer, & Hertwig, 2006). The heuristic is based on the fact that people often make choices by using just one reason and consider a second or third reason only if they have to (Ford, Schmitt, Schechtman, Hults, & Doherty, 1989). According to the priority heuristic, when choosing between two gambles (which lead only to gains compared to the status quo), the first reason people look at is the minimum gains of the two gambles x and y, respectively, $\min(x)$ and $\min(y)$; if $|\min(x) - \min(y)| > c$ where c is a fixed threshold, then the gamble with the higher minimum gain is chosen; otherwise the second reason, which is the probabilities of the minimum gains of the two gambles, is looked up and so on until a reason is found which allows choosing one gamble. The existence of thresholds that allow for a choice or necessitate more search for information is an empirical fact (Tanner & Swets, 1954).

It should be noted that while the models of the pragmatic culture are not primarily inspired or justified by normative axioms, they are amenable to study from a normative or axiomatic perspective. In the former case, the performance of pragmatic models, in terms of criteria such as predictive accuracy, is investigated (Katsikopoulos, 2011b). In the latter case, it is tested whether pragmatic models satisfy axioms such as transitivity or independence (Katsikopoulos & Gigerenzer, 2008; Manzini & Mariotti, 2007, 2012), and pragmatic models are shown to be equivalent to a set of axioms (Drechsler, Katsikopoulos, & Gigerenzer, 2014).

An analogous point can be made for the models of the idealistic culture. Idealistic models are subject to empirical study as in the experimental tests of prospect theory. But empirical facts are not the sole, or in some cases not even the primary, inspiration or justification for the development of idealistic models. For example, a key assumption of cumulative prospect theory – that people weigh probabilities nonlinearly – was inspired by the empirical fact that people's risk attitude depends on whether outcomes are gains or losses and on if the probabilities of gains or losses are large (Tversky & Kahneman, 1992). But, in addition to this empirical fact, there is also a crucial influence of a non-empirical factor on the development of the probability-weighting assumption. This factor is that the assumption is necessary for explaining the pattern if the modeler sticks to the general mathematical form of utility-times-probability which is common in idealistic models. This assumption is not necessary in other models (Katsikopoulos & Gigerenzer, 2008).

Put another way, the 'character' of the idealistic culture is logical whereas that of the pragmatic culture is ecological. Ecology here is meant in Simon's (1955, 1956) sense of the environment – physical or mental – where decision-making takes place. Simon insisted that human behavior could be well understood only if it is studied in relation to its environment. But despite the overall impact of Simon's work, in economics his call has been heeded by the pragmatic culture but not by the much more prevalent idealistic culture.

Other authors have also discussed conceptually the different views on bounded rationality. Gigerenzer (2008) proposes three views, 'as-if optimization', 'ecological rationality' and 'irrationality' (see also Brighton & Gigerenzer, 2012; Rieskamp, Hertwig, & Todd, 2006). As-if optimization is related to what I call idealistic culture and ecological rationality is related to what I call pragmatic culture. The irrationality view refers to empirical research, which has concluded that people systematically violate axioms of logic and probability as in the heuristics-and-biases research program of Tversky and Kahneman (Kahneman, Slovic, & Tversky, 1982; Tversky & Kahneman, 1974). Here, I see this research as part of the idealistic culture of bounded rationality. It forms the empirical basis of this culture and gives rise to the story that people are systematically irrational and the authorities should nudge them toward better decisions, as I discuss in Section 3.

Another author who has discussed different ways of conceptualizing rationality, bounded as well as unbounded, is Lee (2011). He points out that in neoclassical economics, rationality is identified with logical consistency and optimization. Here, I argue that this is also the case in the idealistic culture of bounded rationality. Intriguingly, Lee calls pragmatic the classical economic notions of rationality such as Adam Smith's.

Finally, consider again the labels used for the two cultures. Instead of 'pragmatic', one may be tempted to use another label such as 'empirical'. But I believe that 'pragmatic' is the right choice for the kind of models represented by the entries in the right column of Table 1. A glance at the table shows that these models are 'more practical as opposed to idealistic' which is how the Merriam-Webster Online Dictionary (2013) defines the word 'pragmatic'. For example, in the second row, pragmatic models are defined as those in which a person's goal is to achieve a satisfactory outcome as opposed to attempt to optimize. This kind of pragmatism is successful in the real world as it has been found that, under some conditions, pragmatic models outperform optimization models in medicine, management and engineering (Katsikopoulos, 2011b).

On the other hand, a difficulty with the label 'idealistic' is that this word has all sorts of moral and political connotations. I do not wish to have these connotations ascribed to the bounded-rationality models and stories discussed here. In this article, the idealistic culture

of bounded rationality refers to work inspired by the ideal of an unbounded rational decision-maker who is omniscient and optimizes a utility function.

2.2. *Optimization*

Simon repeatedly questioned the usual assumption of economics that people try to *optimize*. Resounding plain common sense, Simon (1947) pointed out that people rarely even think about how to optimize and instead are content to *satisfice*. As Klein (2001) argues, in the real world satisficing may be the only choice as the optimal outcome may not be calculable or even well defined. The pragmatic culture takes this point to heart and assumes that people's goal is to achieve a satisfactory outcome. For example, Brandstätter et al.'s (2006) priority heuristic does not necessarily lead to choices that optimize expected utility or value but it does guarantee that a gamble with a much smaller minimum gain will not be chosen. On the other hand, in idealistic models such as prospect theory, people are assumed to choose a gamble that optimizes a utility function.

Now, what exactly does it mean to say that people optimize a utility function? The typical interpretation in neoclassical economics is that people behave *as if* they optimize (Friedman, 1953). The claim is not that people necessarily perform all calculations needed in order to optimize but that their behavior agrees with the behavior that results from these calculations. That is, optimization is not meant to describe the underlying *psychological processes*, only their outcome. This neglect of process dominates the idealistic modeling of bounded rationality as well. It may seem odd to argue that, say, prospect theory does not model processes, but it indeed does not in the sense that prospect theory does not specify how exactly it can be that a person would manage to nonlinearly weight probabilities, calculate nonlinear utilities and integrate the two (note that there are elements of a process in prospect theory, as in its initial stage of setting a reference point). I am aware that behavioral economists routinely call their models process models, but if one takes the definition of a cognitive process seriously, this is not so. To be fair, this is a topic of considerable dispute (Berg & Gigerenzer, 2010; Gintis, 2011).

In summary, the third difference in Table 1 is that, unlike the idealistic culture, the pragmatic culture insists on developing process models. Of course, even within the pragmatic culture, there is often disagreement about what is and what is not a process model. It seems that a large chunk of process models describe simple rules of thumb which determine how people first search for information, then stop this search and finally make a decision based on the information gathered. For example, this is the case in the priority heuristic (Brandstätter et al., 2006) as well as in an earlier tradition of models such as elimination by aspects (Tversky, 1972) and satisficing (Simon, 1955).

2.3. *Testing models*

The remaining technical differences between the idealistic and pragmatic cultures have to do with model testing. The fourth difference in Table 1 refers to how parameters are treated. In theory, the parameters should be estimated independently of the data used to test the model. As Luce (1999, p. 727) wrote, parameters are to be estimated '... once and for all ... from experiments designed to do just that'. Gonzalez and Wu (1999), for example, estimated the probability weighting functions of individual decision-makers. Practically, the problems start when model development in a research area is not cumulative enough in order to build on previous parameter estimates. For some

researchers, these problems are formidable and they think we have a 'proliferation of free parameters in many types of theories with little success in developing theories of such parameters' (Luce, 1997, p. 79).

Other researchers are not so wary of parameters (the different points of view are discussed in Katsikopoulos, 2011a). Overall, it is modelers within the pragmatic culture who seem to avoid the use of *free parameters*. It is advertised as a strength of the priority heuristic that it has *fixed parameters* as is also the case in many models discussed by Gigerenzer, Hertwig, and Pachur, (2011). On the other hand, it is routine in behavioral economics to develop models with multiple free parameters.

I will give an example from the literature on bargaining games. Fehr and Schmidt (1999) have developed an idealistic model where players are assumed to behave as if they optimize a utility function. This utility function includes a player's own payoff, but it also includes the player's aversion to inequity, as when earning a smaller or larger payoff than other players. For example, in a two-player ultimatum game where the proposer offers a fraction $p < 1/2$ of a unit pie to the responder and the responder accepts it, the utility of the responder equals $p - \alpha[(1 - p) - p]$ where $\alpha > 0$ measures the responder's envy due to earning less than the proposer, and the utility of the proposer equals $(1 - p) - \beta[(1 - p) - p]$ where $\beta > 0$ measures the proposer's discomfort due to earning more than the responder. These functions can be used to identify which decisions optimize the players' utilities (for the proposer, which p to offer; and for the responder, whether to accept each p or not).

Whereas in the Fehr–Schmidt model parameters α and β are let to vary freely, in a pragmatic model of bargaining games players are assumed to use a toolbox of rules of thumb, each with fixed parameters (Fischbacher, Hertwig, & Bruhin, 2013; Hariskos, Katsikopoulos, & Gigerenzer, 2014). Examples of the rules of the proposer are that she offers $p = 1/2$ or the largest possible p which is smaller than 1/2, and examples of the rules of the responder are that she accepts all $p > 0$ or only those p such that $p > p^*$, where p^* is what she offers when she is the proposer (Hariskos et al., 2014).

Of course, Fehr and Schmidt (1999) did attempt to estimate the parameters of their model. But this is not the point. Leaving aside the fact that there is a controversy on whether the estimation was done properly or not (Binmore & Shaked, 2010; Fehr & Schmidt, 2010), the point is that a model with free parameters already constituted a precisely defined model for Fehr and Schmidt (1999), while this is not the case in pragmatic models.

Now, one could argue that it is close to irrelevant, or just a matter of taste, whether a model uses free or fixed parameters; what matters is if the model can describe empirical facts well. Interestingly, it turns out that the idealistic and pragmatic cultures understand 'describe' and 'well' very differently. This is captured by the fifth and sixth differences in Table 1.

In order to understand these differences, it helps to digress and consider the work of Musgrave (1974). He discusses three views of when an empirical fact lends support to a model. In the logical view, it matters only if the fact is consistent with the model's implications. In the historical view, it also matters if the model's implications where derived before or after the fact was observed. More support is provided for the model if the derivation preceded the observation. Musgrave argues for a third view, a variant of the historical view in which it is additionally relevant what the implications of the best competing model are. More support is provided for the model if its best competitor does not imply the observed fact. Thus, the logical view accepts as an epistemic aim the *explanation of known facts* (here explanation is the consistency of a model's

implications with the facts, ignoring, for example, whether the model proposes causal factors that lead to the facts). On the other hand, the historical view rejects this and aims at the *prediction of new facts*. A second distinction is that Musgrave's variant of the historic view considers it a plus to *competitively test models*, whereas the logical view is silent on that.

It may be argued that the idealistic culture espouses the logical view whereas the pragmatic culture is aligned with the historical view, and in particular Musgrave's variant. More specifically, models that are able to accommodate a wide range of empirical facts are highly valued in the idealistic culture even if the models were developed after the facts have been observed. For example, the development of prospect theory and other risky choice models which follow the utility-times-probability mathematical form, has been following the empirical violations of the axioms of expected utility theory (Starmer, 2000). On the other hand, pragmatic models such as the priority heuristic, have not been developed in order to account for these violations – even though later it was shown that they could do so (Katsikopoulos & Gigerenzer, 2008) – but rather in order to predict new facts. This is the fifth difference in Table 1.

The distinction between explaining known facts and predicting new facts is sometimes acknowledged in work on idealistic models (Blanco, Engelmann, & Norman, 2011; De Bruin & Bolton, 2008; Fehr & Schmidt, 1999). Even in this case, one can discriminate between the idealistic and pragmatic cultures. Idealistic culture only tests models from this same culture whereas in the pragmatic culture models from both cultures are tested. For example, Brandstätter et al. (2006) compared the predictive accuracy of the priority heuristic with that of cumulative prospect theory and Hariskos et al. (2014) compared the predictive accuracy of their toolbox of heuristics with that of the inequity-aversion model. On the other hand, I am not aware of studies within the idealistic culture where the performance of idealistic models is compared to that of pragmatic models. This is the sixth and final difference in Table 1. We next move from modeling to story telling.

3. The two cultures: different stories about people's bounded rationality and how to improve it

Explanation and prediction are examples of the ultimate services that a scientific model can offer. As Morgan and Grüne-Yanoff (2013) argue, however, the intermediate services of models are just as important. Examples of intermediate services of models are to provide 'insights', 'platforms for further discussion' or 'coherent stories' for research to continue (p. 145). In economics, where models are consumed not just by researchers but also by policy-makers and the public and in fact have the potential of affecting people's behavior, intermediate services such as stories are particularly important (Ehrig & Katsikopoulos, 2013; Tuckett, 2011).

According to Morgan (2001, p. 379), a *story* is '... the phenomenon of grasping things together at this intervening level between complete and exhaustive detail and complete generalization'. For a given bounded-rationality culture, I take this quote to mean that this culture's story lies between the empirical evidence and the formal models of the culture. In other words, I see a story as an amalgam of evidence and modeling. In my view, the function of a story is to allow the researchers who produced models, as well as the consumers of the models, including other researchers, policy-makers and the public, to start a conversation about people's decision-making, to keep the conversation going and to give it new twists now and then. This section analyzes the conversations of the idealistic and pragmatic cultures.

3.1. The story told by the idealistic culture

Not only is the idealistic culture inspired by an omniscient and optimizing decision-maker, it never lets go of her, not really. Even though prospect theory and inequity aversion are meant as models of bounded rationality, they live in the shadow of unbounded rationality. For example, prospect theory can, when its parameters are chosen appropriately, be reduced to expected utility theory and so can inequity aversion be reduced to standard game theory. Furthermore, idealistic models of bounded rationality are meant to be descriptive (what does a real person do?) but not normative (what should an ideal person do?), so that whatever researchers have learned from these models has not changed the good old standard of ideal rationality (Bishop & Trout, 2005).

I argue that the story of the idealistic culture goes like this: People are systematically behaving irrationally, but because they are in principle able to figure out how to behave rationally, they should keep trying to do so. It is clear that a person who buys this story will end up as frustrated as Tantalus ever was. This frustration is bound to lead to one of two dysfunctional behaviors: Either deny the reality of making bad decisions and hide in books about ideal rationality in order to get at least some intellectual solace or acknowledge one's dire prospects and surrender to the designs of somebody smarter (which you hope are well-meaning). The first of these behaviors is often seen in neoclassical economics and the second one in behavioral economics.

The first point above is that according to the story of the idealistic culture, people are systematically behaving irrationally. The empirical basis of the idealistic culture is the heuristics-and-biases research program (Heukelom, 2009): This program has concluded that people systematically violate axioms of logic and probability, which the idealistic culture considers to be normative. The irrationality story is told in best-selling books for the public with titles such as *Predictably Irrational* (Ariely, 2008), and has been integrated with startling ease in the columns and blogs of star commentators such as David Brooks of *The New York Times*.

It is important to understand why the irrationality story became such a hit. Lopes (1991) provides an insightful analysis. She points out that until the 1970s, most decision researchers believed that people were pretty good decision-makers (Peterson & Beach, 1967). She finds it implausible that people suddenly started making worse decisions – in fact a bibliographic analysis showed that at that time there was similar amounts of empirical support for 'good' and 'bad' decision-making – and attributes the change to the success of the rhetoric of irrationality. Lopes argues that it was Tversky and Kahneman, who in a series of articles that culminated in an authoritative summary in *Science* (1974), managed to turn the beat around. This article opened up the way for the irrationality message to be spread outside psychology and notably into economics. Today, it is cited almost a staggering 20,000 times, more than classic pieces in economics such as the *Theory of Games and Economic Behavior* by von Neumann and Morgenstern (1944). I single out some of the reasons Lopes provides for this rhetorical success which do not have to do with the truth of the message (a subject of intense disagreement that is beyond the scope of this article, see Gigerenzer, 2007; Kahneman, 2011).

To begin with, the experiments of Tversky and Kahneman are interesting puzzles, not dull drills. For example, in the Linda problem, participants are given the verbal description of a woman which suggests that she may be a feminist, and are asked to estimate if it is more probable that she is (1) a bank teller or (2) a bank teller and active in the feminist movement.

Your spontaneous answer is likely to be (1). Tversky and Kahneman argued that (2) is the correct answer because formally the probability of an event *A* (Linda is a bank teller) is larger than the probability of the intersection of two events *A* and *B* (Linda is a bank teller and active in the feminist movement). So, if you have some education in probability or statistics, you find yourself in the interesting position of having made a mistake, having been able to follow the reasons for it indeed being one and yet still feel somehow drawn to it. As Gould (1988) put it, '... a little *homunculus* in my head continues to jump up and down, shouting at me – but she can't just be a bank teller; read the description'. Furthermore, as you keep on reading the article, you see that most people are like you and have made the same mistake. Fortunately, you can probably convince yourself that you are smarter than most of these people because you do understand what the mistake is. The authors themselves may have fueled your reactions by calling people's decisions 'ludicrous' and 'self-defeating' (Tversky & Kahneman, 1971, p. 109 and p. 107, respectively). As Lopes summarizes, '... [these] problems effectively engage interest and attention while massaging professional egos' (1991, p. 79).

As soon as it has been said that people systematically behave irrationally, the story of the idealistic culture unfolds quite smoothly. Clearly, the story continues, not all of us are irrational since some of us did come up with logic and probability and many of us have studied and mastered these tools. So, there is a job here for whoever can make us more 'rational'. As Lopes puts it, 'the idea that people-are-irrational-and-science-has-proved-it is useful propaganda for anyone who has rationality to sell' (1991, p. 78). The question then becomes: What does the idealistic culture have to sell us? And what about the pragmatic culture?

3.2. Nudge or educate?

When it comes to promoting rationality, the idealistic and pragmatic cultures could have converged to a common story. The two cultures do agree that there is a job that needs to get done: Human decision-making should be supported (note, however, that the two cultures differ drastically in how they view the quality of people's decision-making based on the available empirical evidence and how they go about generating empirical evidence; see Gigerenzer, 1996; Kahneman & Tversky, 1996). But, as I argue below, each culture has its own story on how to get the job done and so far they are sticking to it.

As discussed earlier, the empirical part of the idealistic story is that people systematically behave irrationally. Perhaps because of that, the policy part of this story does not put much faith in people's ability to ever become 'rational' on their own. So, the story goes, if we want people to behave rationally, we somehow have to steer them into doing so. In the words of Thaler and Sunstein (2008), authorities have to *nudge* people toward 'better decisions about health, wealth and happiness'. For example, legislators can set the default option in one's driving license so that people are organ donors, and cafeteria owners can rearrange menus so that children are more likely to eat more vegetables. All the public needs to do is surrender to the well-meaning designs of those who are smarter.

The pragmatic culture tells a different story. This story is based on a different approach to gathering empirical evidence on people's rationality from that of the idealistic culture. The pragmatic culture is indifferent to testing adherence to axioms. It instead focuses on the impact of providing people with tools for boosting performance on tasks of practical importance such as Bayesian reasoning (Fong, Krantz, & Nisbett, 1986). An example of such a task is a medical doctor wanting to know the probability of a woman having breast cancer, given that she is more than 50 years old, the results of a mammography test and the

informativeness of the test. An example of a tool for doing this calculation is natural frequency formats for representing probabilities where conditional probabilities such as the sensitivity of mammography (i.e., the probability that a mammography is positive, given that a woman has breast cancer) are replaced by the corresponding joint frequencies. For example, sensitivity can be represented by the statement that out of 100 women with breast cancer, 99 have a positive mammography. This tool can improve the Bayesian reasoning of professionals (e.g., medical doctors as well as judges and lawyers) and laypeople (Hoffrage, Lindsey, Hertwig, & Gigerenzer, 2000).

In other words, the story of the pragmatic culture is that people can indeed learn to behave rationally. Unlike the case of the idealistic culture, this is not a frustrating message for the public but an empowering one.

Interestingly, the story of the pragmatic culture may not appear particularly empowering when one considers the first premise of this culture which is that people do not optimize. But the story is in fact unexpectedly empowering when we also take into account that empirical studies, computer simulations and mathematical analyses show that pragmatic models can outperform optimization models (Katsikopoulos, 2011b). What is required for reaping the benefits is that people learn, or are taught, which pragmatic model is to be used in which situation. The story of the pragmatic culture is centered on *education*.

Table 2 summarizes the above discussion by outlining three key differences of the idealistic and pragmatic cultures in story telling about people's bounded rationality and how to improve it.

In order to place the differences between the two cultures of bounded rationality into perspective, note that their stories are more similar to each other than they are to the story told by the culture of unbounded rationality. In this culture, which is prevalent in neoclassical economics, modeling is idealistic and the empirical evidence is interpreted as showing that people behave rationally in the sense of conforming to the axioms of logic and probability, except for some random violations; and the policy part of the story is to let people engage in free-market activities and reduce the role of the authorities to activities such as providing incentives.

In 2009, *Nature* published a news feature by freelance writer Michael Bond, covering both nudge and education stories (Bond, 2009). Gigerenzer comes across as a champion of education, whereas Thaler and Kahneman appear skeptical, saying that 'our ability to de-bias people is quite limited' (Bond, 2009, p. 1191) and that 'it takes an enormous amount of practice to change our intuition' (Bond, 2009, p. 1192). There is a standstill and no talk

Table 2. Three key differences of the idealistic and pragmatic cultures in story telling about people's bounded rationality and how to improve it.

Bounded-rationality cultures differences in story telling	Idealistic	Pragmatic
1. Gist of the story	People systematically behave irrationally; they should do better	People do well if they learn to use the right tool in the right situation
2. Psychological reactions of the public	Frustration; surrender to the designs of someone smarter	Empowerment
3. Role of the authorities	Nudge	Educate

Note: The text leading to this table discusses the differences and their relationships.

of combining the two stories (for an exception, see Feufel & Bodemer, 2013). Does it have to be that way? Not necessarily, if we look outside economics.

While bounded rationality is more famously developed in fields that share the goal of describing human behavior such as economics and psychology, it has also been studied in disciplines that share the goal of prescribing human behavior such as engineering design, systems engineering, operations research and management science. Interestingly, Simon (1968) was involved in all of these fields as seen in *The Sciences of the Artificial*. Thus, one may expect that the pragmatic culture is part of the tradition of the prescriptive fields. Although this is true to some extent, the idealistic culture still reigns. For example, the new field of behavioral operations management has essentially transferred the approach of behavioral economics to the study of the management of operations such as supply chains (Katsikopoulos & Gigerenzer, 2013). This can be seen in how the field is defined as the study of biases (Carter, Kaufmann, & Michel, 2007), in the flurry of optimization models that are being developed (Loch & Wu, 2005) and in the neglect of the underlying psychological processes (Croson & Donohue, 2002). In the field of engineering design, pragmatic models have been received with furious anger by proponents of idealistic modeling who controlled funding in the *United States National Science Foundation* for years (see the response of Hazelrigg, 2010 to Frey et al., 2009).

Nevertheless, the pragmatic culture seems to be gaining some momentum in fields interested in prescription such as engineering and management. To begin with, there is the actual publication in top journals of studies that criticize or simply offer alternatives to the idealistic culture (Frey et al., 2009, Katsikopoulos & Gigerenzer, 2013). In addition, leading researchers, such as Robin Hogarth, have investigated the performance of pragmatic models and argued for their normative and prescriptive power (Baucells, Carrasco, & Hogarth, 2008; Hogarth & Karelaia, 2005). Last but certainly not least, important institutions with a central regulatory function, such as the *Bank of England*, have brought pragmatic models into the foreground (Aikman et al., 2014; Haldane & Madouros, 2012). It may be that the conversation is about to change and the idealistic and pragmatic stories combine.

4. Conclusions

Scientist and novelist C.P. Snow (1959) lamented the schism between the two cultures of the sciences and the humanities. This article has the much more modest goal of analyzing the research on bounded rationality. Bounded rationality would have perhaps pleased Snow, as it exhibits technical as well as story-telling aspects. On the other hand, here I showed something that could have worried Snow: There exist two distinct cultures of research on bounded rationality, the idealistic and the pragmatic, and they lead to two very different approaches to economic theory and policy. Time will tell what will come out of this tension. But if we are not aware that it exists, we cannot hope to make something good out of it.

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