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Rational, Normative and Procedural Theories of Beliefs: Can They Explain Internal Motivations?

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Abstract: This paper offers three-way taxonomy of theories of beliefs. For rational theories, beliefs are determined by given information and updated via Bayes's rule. For normative theory, best represented by Hayek and sociological theory, beliefs are categories that precede information and, in fact, formulate the otherwise impenetrable information. For procedural theory, best represented by Herbert Simon and pragmatic philosophy, while beliefs formulate the information, they can be replaced in response to shocks. While each theory manages to capture one kind of belief, all three largely fail to explain internal motivations that characterize entrepreneurship, innovation, and creativity. The failure arises from the fact that the three theories are about cognitive beliefs (i.e., beliefs about the world), while internal motivations are beliefs concerning self-ability.

Keywords: Bayesian fallacy, creativity, four kinds of beliefs

JEL Classification Codes: D03

Why Beliefs?

This paper analyzes the structure of three different theories of beliefs: the rationality approach associated with neoclassical economics, the normative approach associated with the work of Friedrich Hayek, the procedural approach related to the work of Herbert Simon and, to some extent, the contribution of Thorstein Veblen. Beliefs and belief formation are of great importance to economic theory. Every action is based on a set of beliefs. Even a mundane action, such as whether one should carry an

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umbrella, depends on one's belief of the likelihood of precipitation, the estimate of walking distance, availability of shelter, and so on.

One payoff of the proposed three-way taxonomy is to demonstrate a subtle, but hardly noted, similarity among these three main theories of beliefs. This can be a surprising payoff given the widely held view that these three approaches are very far apart. However, with regard to the phenomenon of entrepreneurship and internal motivations in general, the three main theories lack the machinery needed to account for this phenomenon. The reason, as argued in the paper, is that the three approaches, in the final analysis, treat one's belief about one's ability for an aspirational goal (an internal motivation) as no different from one's belief about one's external environment such as the weather, traffic, or the movement of the stock market. The paper argues, but with some nuances, that the cognitive processes concerning the formation of beliefs concerning the environment and *given* facts differ from the cognitive processes concerning the formation of beliefs concerning one's aspirational goal. The main reason behind the difference is that one's aspirational goal can never be a *given* fact.

But why should economists be concerned with aspirational goals or internal motivations? If we think of internal motivation as the engine of creativity and entrepreneurship, internal motivations are crucial for productivity growth and, correspondingly, relevant to policymakers interested in sustaining improvements in well-being. Actually, James Heckman (2007; Heckman and Krueger 2003; Heckman and Rubinstein 2001) has identified a puzzle as to why investment in education has declined, at least in the United States, while the expected returns from the investment have been rising. This phenomenon, of course, is an anomaly to neoclassical theory that stresses *external* motivations (i.e., incentives). Heckman, in response, has turned his attention to the role of *internal* motivations, what he calls "non-cognitive" skills, to the point of focusing his research on the nursing of children (and even primates) in the first years of life.

But what is a "belief" and how is it related to institutions? A belief is a mental guide that accords probabilities of uncertain states of the world. A belief is also a guide about the self and how it can cope with these states of the world. As such, the focus is not on the broad question of institutions, which can be defined as explicit rules or remedies that supposedly improve transactions, organizations, and markets. The focus of this paper is rather on the narrow question of institutions insofar as beliefs are seen as implicit, non-formal institutions. So, institutionalist economists, especially ones concerned with motivations behind the action of persons and firms, should be concerned with beliefs and belief formation.

There is, in fact, a direct connection between beliefs and explicit, formal institutions. For instance, one may believe that one does not function viably when one, who is trying to lose weight, faces a temptation upon encountering a chocolate cake after dinner. In response to such a belief, one may erect a self-control mechanism (a pre-commitment, i.e., an institution), that limits one's exposure to chocolate cakes. Likewise, if one believes that others are prone to cheat or misconceive the magnitude

of their contribution to a public good, one may respond by setting up a governance structure (i.e., an institution), to remedy the problem.

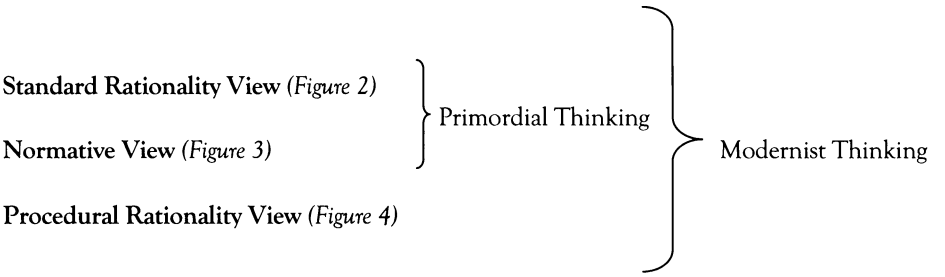
As for the proposed three-way taxonomy of the theories of beliefs, let us state them briefly. First, for rational choice theory, a choice is undertaken to maximize an optimum in light of beliefs, which are in turn determined optimally by the available information in light of Bayes's rule. Second, for normative theory, the belief is not determined by information, but rather (if it can be put at first approximation) *vice versa*. That is, the information starts to make sense once it is cast or framed by *given* beliefs. Normative theory is dominant in traditional sociology. It is gaining adherents in organization theory (e.g., Egidi and Rizzello 2003; Nooteboom 2009) and can be traced back to the "embodied cognition" approach of Hayek. Actually, Hayek's view of the mind is resonating among some modern neuroscientists (e.g., Damasio 2003a, 2003b, 2005; Lakoff and Johnson 1999; Mareschal et al. 2007; Varela, Thompson and Rosch 1991).

Third, for procedural theory, while the belief frames the information, the belief is not *given*. It is rather replaced in reaction to external shocks or hazards. Procedural rationality can be traced to Simon's (1976) theory of action and to American pragmatism, especially John Dewey's later work with Arthur Bentley (Dewey and Bentley 1949).

This paper has two aims: first, it provides a taxonomy that clearly deciphers the differences among these three broad theories of beliefs. Second, it argues that, despite their differences, the three broad theories cannot account for creativity, entrepreneurship, and internal motivations (i.e., aspirational goals). The reason is that in the final analysis the three theories treat all beliefs as if they are born equal. But not all beliefs are born equal. The belief responsible for creativity, entrepreneurship, and internal motivations – called here "convictions" – differ from three other kinds of beliefs: *confidence*, *perception*, and *conception*. To delineate the differences among convictions, confidence, perception and conception, we need to see how information is processed in order to form the belief, in particular, how Bayesian updating is involved or not. To ignore the differences in how information is processed, and the consequent conflation of the four kinds of belief, amount to a "Bayesian fallacy." This paper shows how each of the three broad theories of beliefs (rational, normative and procedural approaches) commits the Bayesian fallacy, and commits it in a different way.

We first establish why all beliefs are not born equal. The first section delineates among four kinds of beliefs. The rest of the paper delineates the difference among the three broad classes of theories of beliefs and how they, differently, fail to distinguish among the four kinds of beliefs. Figure 1 provides a thumbnail guide of the three classes of theories. Section two discusses the rational choice theory of beliefs which is dominant in economics and behaviorism in psychology. Rationality theory generally treats convictions as no different from confidence and perceptions (i.e., as the optimum products of information via Bayes's rule). The third section demonstrates the normative theory of beliefs (Friedrich Hayek's ecological rationality approach) which is dominant in sociology and anthropology. Normative theory broadly regards beliefs, and correspondingly actions, as the outcomes of given norms or rules that actually frame and cast the information into

Figure 1. Theories of Beliefs



meaningful statements. Section four elucidates procedural theory that typifies classical pragmatism (Simon's approach). It basically maintains that beliefs, while they shape information, are in turn influenced by information as a result of sudden shocks.

This paper is restricted to modernist views of beliefs. It avoids postmodernist theories that promote, in different ways, solipsism or the rhetorical approach in the tradition of Friedrich Nietzsche (1989).[1]

Four Kinds of Beliefs: Conviction, Confidence, Perception, Conception

The Problematic Belief: Conviction

The species of beliefs that concern one's aspiration about the potentiality of one's human capital such as the belief that one can conquer an enemy, climb a mountain, or undertake a business enterprise is called "convictions." Convictions are the basis of internal motivations and imagination of human possibilities — motivations and images that cannot be simply explained in terms of external incentives or stimuli.

Convictions are beliefs that fuel our internal motivations such as acting with tenacity to achieve a goal. Even when agents fail to put their convictions into action, upheld convictions still have the potential to fuel internal motivations and, hence, should still be considered as convictions. The fact that people may not act on their conviction is a secondary, if not tertiary, issue — which would require a fuller/richer account (including sociological and psychological profiles) of action. Such an account falls outside the scope of this paper.

Convictions are commonly couched in terms of religious dogma, such as God is on one's side as one tries to conquer an enemy or climb the mountain. Convictions equally can be couched in secular dogma, which is probably behind the self-help industry from books, videos, and motivational workshops. In either case, convictions amount to expressing one's determination vis-à-vis a challenge or a goal: One's belief that he or she can play the piano entails improvement of one's human capital or self-ability as one tries to act on the belief. That is, the object of the belief (self-ability) changes as one tries to act on

the belief. It even changes as one tries to test "scientifically" the validity of the conviction. The testing involves taking an action. This necessarily entails the development of the object (i.e., self-ability), which the agent is trying to test. The expression of the conviction to produce, achieve a goal, or meet a challenge amounts to presenting the self with a context or a frame, which in turn acts to motivate the self to act.

In this sense, the creative core of convictions is not about uncertainty, whether uncertainty in the standard neoclassical sense (of known probability set) or in the Keynesian sense (as unknown probability set). In the Keynesian sense, uncertainty is about moods, emotions, anxiety, or "animal spirits" that cannot be objectively quantified or predicted with some probability distribution (see Dequech 2003, 2006). But the non-quantifiability of Keynesian uncertainty does not make it the ground upon which we can construct a theory of conviction, creativity, and entrepreneurship. Keynesian uncertainty is ultimately orthogonal to the issue at hand. We could be invaded in a year by aliens, gripped by fear of market collapse, or another event that cannot even be imagined. But such uncertainty, and the emotions that it can evoke, does not address the issue of rationality in relation to convictions. To start with, the theory of rational choice never entailed the ability to know all forces of nature, black swans, or predict things that can be radically unexpected.[2]

Convictions involve creativity for a different reason. Namely, human capital is always a potential and, hence, to define it involves action that forces human capital to develop. Convictions can be encased in spiritual beliefs which may become detailed, where the details are ossified into religious dogma and institutionalized temple. The dogma is normally insulated from experience (action) – although in the long-term it is informed by life-core situations. Even if the dogma is insulated from experience, the core content of the conviction – such as the ability to overcome an odd or to succeed in a task – does change as the person undertakes the challenge. Insofar as religious dogma is immune from change in light of experience – such as beliefs in the holy trinity or immaculate birth of Jesus – the dogma does not involve pragmatic script of what challenges one should adopt. Such high-level dogma, or static convictions, are ignored here. The focus is rather on convictions that entail pragmatic program of action. As such, the object of the convictions (i.e., self-ability), is susceptible to change as a result of action.

Note, human capital as articulated by convictions differs from the neoclassical concept of human capital as epitomized in the work of Gary Becker. For neoclassical theory, the belief concerning self-ability (human capital) is evidential – something that is formed by Bayes' rule – and, hence, supposedly similar to other beliefs such as perception, which concerns one's social and natural environment, weather, and other data. While for some policy purposes, such as public policy concerning investment in education and skill training, it might be practical to treat human capital as data, it should not mean, at first theoretical approximation, that beliefs concerning human capital or ability are data.

The paper argues that beliefs about *given* facts differ radically from conviction. Put tersely, the content of these three kinds of beliefs (confidence, perception, and conception) do not change as a result of finding out about the belief, while the content of conviction changes as one tries to find out the content.

Confidence

Despite the noted similarity among the three kinds of beliefs (confidence, perception, and conception), viz., how they differ from conviction, these three beliefs differ from each other.

Let us start with "confidence." The term is used here to denote the species of beliefs that, similar to conviction, also concern the self. However, as defined here, confidence is the belief that one's internal rules of ethics, obligatory commitments, and will-power are strong enough to help the agent withstand dynamic inconsistency – also known as weakness of will or *akrasia*. That is, the term "confidence" does not correspond exactly with the broad usage of the term, which denotes the idea that one has "self-confidence" when one, as supposedly the case, feels that one has the self-ability to achieve something. This meaning would connote "conviction" as defined above.

This paper uses the term "confidence" in a more limited sense, as when one states: "I can abstain from having a second piece of chocolate cake," "I can withstand the temptation to cheat on an exam," "I can trust myself and would not free ride," or "I can trust that my neighbor will not renege on his word." In these cases, the agent is expressing the belief that he or she can trust him- or herself or trust others. In these cases, the object of confidence, viz., the will to stay the course and not surrender to temptation and betray the future self (in case of eating the cake) or the other (in the case of the neighbor), does not improve as one stays the course. Let us say that one trains him or herself to do mental tricks, what Adam Smith calls "self-command," in order to fight the biological cues (i.e., the temptations), upon one smelling a piece of cake (Khalil 2010a; Smith 1982). Once one has self-command, and one does not eat the cake, one's will does not need further improvement. At the end, the practice self-command does not lead to further self-development because there is no further goal than simply trusting oneself to abstain from eating the piece of cake. The practice of self-command at best attains self-command, that is, a final and well-defined end.

Put differently, one may erect an internal rule, such as "always eat salad with dinner" when one does not favor salad. The practice of eating salad each night does not lead to the improvement, other than maintenance, of the strong-will trait. Given that one has a strong will, and follows the internal rule, one's strong will does not become better over time. In contrast, the object of conviction, viz., the ability to play the piano, improves as one plays the piano, and such improvement has no limit.

Ultimately, the difference between the two kinds of beliefs lies in the fact that convictions entail actions of production where the aspirational goal is not about *given* facts, while confidence entails rules that are about *given* facts and, in light of these facts the agent imposes restrictions or commitments to avoid succumbing to temptations (Khalil 1999). As such, actions of production lead necessarily to improvements of ability, while restrictions prompted by the avoidance of temptations such as overeating, cannot lead to improvements because the deleted options are not even chosen.

Perception

The other two kinds of beliefs (perception and conception) also have contents that do not develop. But they differ, as a set, from conviction and confidence in one regard. The objects of perception and conception involve the external environment, not the internal self.

To detail, the term "perception" is used here to denote the species of beliefs that concern descriptions of one's surrounding, whether made of humans, plants or rocks. For instance, perception involves statement: "The Earth is flat," "the temperature is reaching 100 degrees," "the GM stock value will rise tomorrow," and "Liverpool will win the football game next week." While the last statements are predictions, the predictions of facts are facts that must be supported by evidence – as much as the description of horse movement or the estimation of the average temperature of Northern Europe in the fourth century is based on evidence. Perceptions are similar to scientific statements and theories in the sense that they are supposed to be based on empirical facts. To wit, confidence is also based on empirical facts – which explains why agents with weak will usually resort to precommitments and external constraints in order to avert temptations. So, perception and confidence are evidential beliefs – unlike convictions that can be called non-evidential beliefs.

Note, the biological machinery behind perception is part of one's self-ability – and hence evolves through conviction as developmental psychologists are ready to point out. But the issue is not the neural/psychological machinery that allows perception. Rather, it is the content of perception. If one sees, for example, a horse running across the field, the machinery (whether a biological eye, a camera, or a robot) is irrelevant to the issue. What is relevant is whether the belief can be tested without influencing the content (horse running). In the case of perception, the content can be tested without influencing whether the horse is running across the field. In the case of conviction, as defined here, it cannot.

Conception

In contrast, "conception," the last of the four beliefs, is defined here as somewhat similar to perceptions: conceptions are perceptions that are couched within a frame or context. Thus, conceptions are somewhat similar to convictions in the sense they are non-evidential. Examples of conceptions include: "the temperature is reaching 100 degrees, which is lower than expected," France will win the football game in 2012, which would be amazing," "the stock market major index fell 5%, which brought relief because investors were expecting an 8% drop," and the "glass of water is half-full" (instead of being half-empty). While these statements are scientific, they have non-evidential elements by the fact that the belief is posed against a context or background. However, conceptions cannot be convictions, which are also posed against a context or background. The object of the conception (temperature or quantity of water in the glass) does not evolve as a result of the context. In contrast, the object of the conviction (ability to climb mountain) evolves as a result of the context or challenge.

The Two-Axis Information Taxonomy

Table 1 provides a two-axis information taxonomy that renders the difference among the four kinds of beliefs clearer. Along one distinction, the information is either about the internal (self) or the external (environment). Along the other distinction, the type of information is about content or context. So, confidence is about the internal and is related only to evidential grounding (content information). Perception is about the external and is also related only to evidential grounding (content information). Conviction is about the internal and related to non-evidential grounding (context information), which frames or casts the content information. Conception is about the environment and is related to non-evidential grounding (context information).

Table 1: Two-Axis Information Taxonomy

		Domain of Information	
		Internal (Self)	**External (Environment)**
Type of Information	**Evidential (Content)**	*Confidence*	*Perception*
	Non-evidential (Context)	*Conviction*	*Conception*

Note, the role of context in conception does not instigate internal motivation as in the case of conviction. The major point of this paper is to highlight the unique status of convictions. Such beliefs are the basis of tenacity, perseverance, and innovativeness — which sets them aside from the three other beliefs.

The importance of convictions underscores the payoff of the exercise undertaken in this paper. Namely, the delineation among the four kinds of beliefs is of great interest given that tenacity and innovativeness, which spring from convictions, are the bases of entrepreneurship and economic growth. Put differently, it is commonly acknowledged that rational choice theory cannot, at first approximation, account for entrepreneurship (Boettke, Lavoie and Storr 2004). And, if entrepreneurship is the product of convictions, it would be of utmost importance to investigate whether the three major theories of action can account for convictions.

As noted at the outset, the three major theories of beliefs fail to distinguish among the four kinds of beliefs. Of particular interest, they fail to distinguish three kinds of beliefs from convictions (i.e., beliefs concerning internal motivations). The main reason is that they treat all kinds of beliefs as mainly concerned with cognition of *given* facts. Hence, they largely fail to note that beliefs about aspirational goals, which cannot be about *given* facts, differ greatly from the other kinds of beliefs. So, in the end, the three major theories of beliefs basically provide the same theoretical machinery, ignoring the subtle differences among beliefs.

The failure to distinguish among beliefs generates what has been called elsewhere the "Bayesian fallacy" (Khalil 2010b). To define it briefly, one commits the Bayesian fallacy when one disregards the subtle differences among beliefs and, consequently, applies Bayes's rule of updating the belief as if all beliefs are born equal. Bayes's rule can be applied strictly only when the belief is based on external information that is itself not subject to change as a result of the belief. Otherwise, it would be a belief that is chasing its own tail. But this is only the case with confidence, perception, and (with some qualifications) conception. It is not the case with conviction. Each broad class of theories of beliefs fails differently to distinguish among the different kinds of beliefs and, hence, commits the Bayesian fallacy to a different degree.

The most serious degree is called here the "first-degree Bayesian fallacy." It is usually committed by the standard theory of choice. It is the most serious fallacy because the standard view of regarding beliefs as the optimum outcome of information actually involves the Bayesian fallacy along two dimensions. The first dimension amounts to regarding information as context-free (i.e., as potentially free of prejudice, preconception, or belief). That is, it is supposedly possible for an agent to choose a belief in light of some immaculate information that can be, at least theoretically, non-tainted by the belief itself.

The second dimension amounts to ignoring the fact that the objects of one kind of belief, viz., convictions, involve self-ability, and self-ability must evolve *as a consequence* of the belief itself. In contrast, the object of the other three beliefs – confidence, perception, and conception – does not evolve as a consequence of the belief itself. If one holds the belief that he or she can climb a mountain, the actual test of that belief entails that the agent's ability mutates and evolves. In contrast, if the object of the belief is whether the picture involves two women rather than two trees or whether one can handle temptations, such an object of belief does not mutate or evolve as a result of testing the belief. In the case of convictions, one can never know with any degree of certitude whether the belief is true or false. Each time the person attempts to find out, it must necessarily entail an exercise that forces the ability itself (the object) to mutate or develop. Note, one cannot apply Bayes's rule if the *ex ante* belief itself, such as the probability that one can climb a mountain, when the object itself (the probability) is non-definable.

The less serious degree here is called the "second-degree Bayesian fallacy." It is usually committed by the other two broad classes of theories of belief: the normative and the procedural. This is a less serious fallacy because it involves the commitment of the fallacy only along one dimension. These two broad classes of theories recognize that information, or at least some information, is context-laden. That is, there is no belief-free information. The information at hand is casted and framed in light of given beliefs. However, the two broad classes of theories commit the Bayesian fallacy along the second dimension mentioned above. Namely, they do not realize that convictions differ from other beliefs: While convictions involve objects that are non-definable as a result of the evolution of the objects of the beliefs, other beliefs involve objects that do not change as a result of the belief. These two broad classes of theories tend to think of beliefs as a matter of knowledge, failing to see that convictions involve productive activity (such as climbing the mountain) that entail the change of the object of the belief itself.

The difference between the two degrees of Bayesian fallacy should become clear once we differentiate among the three broad classes of theories.

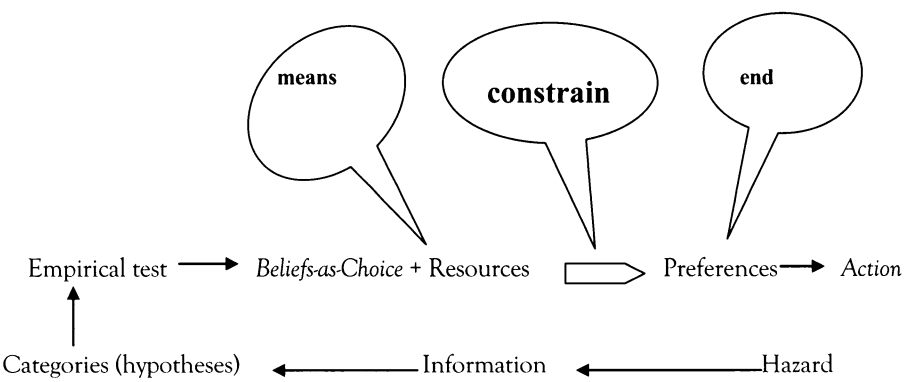
Standard Rationality View: Belief-as-Choice

Belief Formation

According to the standard rational approach, as Figure 2 shows, agents choose an action as the result of means (the budget function) that constrain the ends (the preference set). An action is a choice in the sense that the agent can substitute among preferences in light of incentives. Such substitution, according to standard theory, takes place in light of the set of means (constraints) that consist of resources and beliefs. The beliefs consist of generalizations about causality and know-how of how resources can be mixed. The beliefs are determined rationally, in light of the available information. The available information is tested and categorized in a way that gives rise to the best (optimum) beliefs. The beliefs are updated continually via Bayes's rule. That is, the agent would change his or her belief about the probability of an event in light of new information or a new test of available information.

John Dewey and Arthur Bentley (1949) call this view "interactional" because the source of the change of belief, and the corresponding change of action, is some external input of information. For behavioral psychologists, the external input, which they call stimuli, is the primary motor of action. Don Ross (2005) convincingly argues that the rational choice model is basically grounded on an externalist framework, where action is fully explained in terms of changes in the external environment. For the rational choice approach, beliefs are also shaped and updated by external events. In this sense, the rational choice approach covers *all* beliefs, and not only conceptions and perceptions about regularities of nature (including one's society). Namely, it covers beliefs about one's self, what is called confidence and conviction, and treats them no differently than data from

Figure 2. The Standard Rationality View of Beliefs



beliefs about the environment. For the rational choice approach, *all* beliefs, regardless of their type, are justified by available empirical evidence via Bayesian updating.

Such updating is crucial in game theoretic settings. In game theory, especially in evolutionary game theory (Bowles 2004, ch. 2; Frank 1987; Mailath and Samuelson 2006), players choose strategies depending on their belief of the type of the opponent, when such type is relevant. In some theories, agents have to guess if the opponent is rational. Otherwise, if there is a chance that the opponent is "crazy," non-credible threats cannot be dismissed (Kreps et al. 1982).

For the standard rational choice, beliefs are updated by signals. For such a view, there is no difference between evidential beliefs (confidence and perception) and non-evidential beliefs (conception and conviction).

Lumping of the Four Kinds of Beliefs

The rationality approach does not make a distinction between external beliefs (perception and conception) and internal beliefs (confidence and conviction). While confidence, perception, and conception are sensitive, in different degrees, to empirical evidence, they do not lead to self-development because the object of these beliefs, the environment, is given. This is not the case with regard to convictions. The object of convictions (the self) develops with action. The standard rationality approach, hence, commits the first-degree Bayesian fallacy in the sense that it treats convictions as no different from scientific theories (i.e., as no different from beliefs about the environment when context is not involved). In this sense, it ignores the issue of context that underpins convictions and, further, it ignores that the object of conviction (self-ability) can evolve or develop.

The lumping together of convictions with other beliefs is illustrated in Figure 2 by "*Beliefs-as-Choice*." The direction of causality between beliefs and empirical evidence makes no distinction of whether the belief is Bayesian, quasi-Bayesian or non-Bayesian. Beliefs are seen as the result of a confirmation method: categories and hypotheses are the products of empirical evidence. Beliefs are justifiable insofar as the limited, but available, empirical evidence supports them. The evidence afforded by the information can change as a result of a hazardous event, that is, an exogenous shock that changes the content of information or the cost of collecting information. So, as shown in Figure 2, it is the hazard that sets the whole mechanism into motion. When hazard strikes, the relative costs of information changes, which means the agent now has a new optimum level of information. The new optimum level induces the rise of new mental categories that in turn, give rise to new beliefs and consequently, to new (optimal) action.

The interactional model of action-as-choice, however, faces a problem: the action might be *indeterminate*. This is because the same agent may take two different actions, even when there is no change in the data in terms of preferences and constraints. The reason, as already discussed, is framing: actions taken do, in reality, depend on changes in the context, which, according to the standard rationality approach, should be irrelevant since context cannot be part of the data: an agent should not make a decision whether to drink from a glass based on whether he or she sees it as half-full or half-empty.

One should note, however, that some changes in decision — such as an agent hesitating to buy a home that he or she discovers to be next to a funeral parlor, or to eat steak after a visit to the slaughterhouse — that might appear to concern context, actually concern data. The encounters or availabilities of funeral parlors or slaughterhouse visits do indeed invoke certain emotions, but these emotions are based on content data, that is, associations that hinder the consumption of the good. And, context does not involve content data: it is about the manner in which the *same* information is presented; it is about the framing of data in a language of loss or gain (Tversky and Kahneman 1981).

The fact that some beliefs — and hence actions — can change without any change to the empirical data undermines the basic assumption of rational choice. It also undermines the basic assumption of empiricist methodology, viz., the assumption that the mind is ultimately a blank slate (*tabula rasa*). After all, some facts do not speak for themselves. The agent may have to organize some facts according to beliefs or categories that cannot be empirically based.[3] So, the empirical evidence is not, at least in some cases, as innocent as the standard rationality approach may lead us to believe: it is constructed (individually or socially) by the context or perspective that the agent brings with him or herself.

Consequently, in light of the relevance of context, a theorist faces two options. One can follow David Hume and become skeptical of beliefs themselves, and argue that they are merely figments of the mind. Or, one can conclude that empirical evidence, after all, is not the prime mover. The latter option is the basis of the normative view discussed next.

The Normative View: Belief-as-Norms

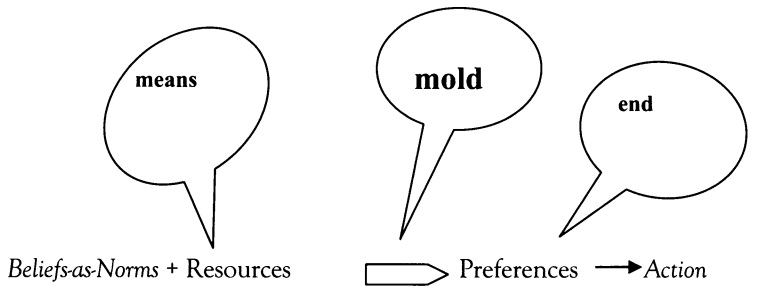
Belief Formation

The normative view is what basically defines the approaches of classical sociology and anthropology (Joas 1996). It also underlies schools of psychology that stress the importance of personality traits or childhood history in determining current behavior. These approaches minimize the influence of incentives or stimuli.

To be clear, the normative view is orthogonal to the debate between reductionism and holism (i.e., whether the traits/predispositions of agents are socially as opposed to biologically determined). The reductionism/holism debate in evolutionary biology concerns the proper unit of selection. In the social sciences, it translates to whether organizations, such as states and firms, are better understood in terms of the strategies and actions of persons (Hodgson 2004b). Such a debate should not shed light on the explication of types of beliefs. Reductionists, such as Hayek, uphold the normative view — similar to holist thinkers. Further, Richard Nelson and Sidney Winter (1982) conceive routines as only social- or population-level phenomena. On the other hand, Simon (1957, 1976) views routines as both social- and individual-level phenomena. This paper does not delve into the methodological individualism debate because it is orthogonal to what is conclusive about the normative view of beliefs.

Dewey and Bentley (1949) call the normative view "self-actional" to signify that the view regards the primary source of behavior to be internal disposition, as opposed to the external environment, incentives, or stimuli. Figure 3 captures the core of the normative

Figure 3. The Normative View of Beliefs



(self-actional) view. Here, the set of means *molds*, rather than constrains, preferences after its own image. The molding is carried out by beliefs-as-norms ranging from biological needs, psychological imperatives, social roles, and cultural customs. So, the end result, action, is not primarily formed by environmental incentives. The action of the agent – whether seen as a person or a social group – is rather rigid vis-à-vis the environment.

The normative (self-actional) view basically does not try to explain the origin of beliefs. People behave in certain ways because of their cultural norms, mentality, or childhood inhibitions. The normative view may allow for hazards to influence the formulation of beliefs. In any case, however, once formed, beliefs-as-norms generally mold the information of the environment after their own image. Logical reasoning may then act to make the beliefs internally consistent. But the beliefs are ultimately formed prior to empirical data. That is, beliefs are not, at first approximation, formed by empirical data – contrary to the standard rationality view.

Related Literature

There has been great attention paid, with the recent revival of postmodernist thinking, to the importance of language as the entry point of theorizing. That is, language supposedly encourages certain beliefs that explain behavior. In particular, according to Ludwig Wittgenstein and other postmodernist thinkers, terms and phrases that a culture employs have, firstly, little meaning without context, and thus cannot refer to person-independent reality (Winch 1958). Secondly, words and phrases only make sense in relation to other words as formulated in sentences. Sentences thus make sense of an originally unlabeled world by structuring the environment of everyday experience according to their own meaning. If this is the case, the information that agents see is already entailed by their own particular linguistic heritage. So, agents examine their environment within a norm, or what John Searle (1999, 2001) calls "background," which is woven into a "socially constructed" reality.

Thorstein Veblen, or at least how his followers interpret him (Khalil 1995), somewhat advances a normative view, where norms were regarded as socially constructed. The normative view, though, need not be based on the view that norms are socially

constructed. Some thinkers, such as Hayek (1952, 1967, 1978), advance a normative view that is based on asocial and reductionist grounds. Hayek argues that the mind is inherently ordered around categories or units of "knowledge." Such categories are profoundly subjective (Boettke, Lavoie and Storr 2004). The "subjectivity" notion entails that mental categories precede experience and, hence, the categories frame what one conceives (Scazzieri 2002). This view of knowledge is reminiscent of the embodied cognition view of Lakoff and Johnson (1999), and Varela, Thompson and Rosch (1991), which argues that the categories of knowledge arise largely prior to experience. The categories are seen, at first approximation, as the determinants of experience. Such a proposition has not, however, gone unchallenged. For instance, Andy Clark (1997) appreciates the idea that our categories are not mirror reflections of objective reality, but he nonetheless argues that they cannot be seen as constructs that precede experience. Similar to Clark, Edward Feser (2003) argues that Hayek considered the things in-themselves to be beyond knowledge that can be discovered by experience. Hayek's view, according to Feser, is thus based on the assumption that experience is shaped by *a priori* categories. This is problematic because it begs the question about the origin of such categories.

The same question arises with respect to the approach of Antonio Damasio (2003a, 2003b) and a host of others (cf. Elster 1998; Greene 2005). For Damasio, most of human behavior, norms, and moral values are determined by the emotions. On the other hand, he views reasoning as only a secondary phenomenon: he even argues that it is merely a social construction or a "justification" of moral intuitions, which are, in turn, formed prior to any interaction with the environment (Damasio 2005, 53). Such a view affirms the Cartesian dichotomy between the emotions (intuitions) and reasoning – but unlike Descartes, Damasio emphasizes how emotions act as hidden processes that are more perennial than rational deliberation in how decisions are made. For Damasio, the emotions are the states of the organism that shape the organism's specific wants. Therefore, choice is seen as expressive of some innate or indoctrinated norms.

Two Problems

The normative (self-actional) view of action-as-norm, however, faces two problems. First, as suggested above, the normative view basically cannot answer the question concerning the origin of beliefs. And when "society" or "culture" is invoked as the source of beliefs, it only postpones the questions: why would a society or a culture choose one norm over another? The normative view cannot provide reasons grounded on the set of means, such as geography or technology, because it would mean that beliefs are optimum outcomes. The normative view must thus ultimately rely on hazard or accident to explain the origin of beliefs.

In this regard, the normative view resembles a core assumption of neo-Darwinism. For neo-Darwinism, the genotype also arises from hazard or accident. For neo-Darwinism, the behavior of the agent – whether conceived as organism or social group (Sober and Wilson 1999) – is more-or-less determined by the genotype, irrespective of the environment. But there is one difference between the two views. For neo-Darwinism, natural selection ensures that the best genotype is allowed to

procreate at a rate greater than other genotypes. Over many generations, the behavior of the organism is then said to be optimum – in the same sense as if the behavior is the outcome of rational optimization.

The normative view, however, does not recognize that there are many kinds of beliefs. In particular, one type of belief, viz., the Bayesian belief, can indeed be grounded on empirical data and learning – as in the case of finding out about the weather tomorrow or who won a football match ten years ago. Such beliefs are formed on the basis of an optimization process undertaken in light of feasible information that is costly in light of constraints such as geography and technology. So, we do not need to appeal to hazard and accident to explain the origin of such Bayesian beliefs. But since these beliefs are not recognized by the normative approach, the normative approach is left with no other choice but to appeal to hazard and accident to explain the change of belief.

Concerning the second problem, even when beliefs originate from non-empirical categories, the normative view fails to disentangle convictions from conceptions. This is discussed in the next section, since the procedural rationality view also fails to disentangle convictions from conceptions. That is, both views commit the second-degree Bayesian fallacy.

Procedural Rationality View: Belief-as-Routine

Belief Formation

While the standard rationality (interactional) view traces the categories to empirical evidence, it cannot ultimately explain why the same evidence can give rise to different beliefs. On the other hand, while the normative (self-actional) view traces empirical evidence to categories, it cannot explain Bayesian beliefs, for which empirical data is primary.

As Peter Godfrey-Smith (1996) shows, Dewey proposed an alternate account to supersede the shortcomings of the standard rationality and normative views. Dewey's account resonates well with heterodox institutionalist economics as evident in the works of Richard Nelson, Douglass North, and, earlier, Thorstein Veblen (Khalil 2003, 2007). Economists working within the heterodox institutionalist approach generally do not view agents, at first approximation, as maximizers. They may not go as far as Simon's procedural rationality in ignoring the roles of conviction, creativity, tenacity, and entrepreneurship.[4] Still, though, they basically regard beliefs as the default position – similar to how agents find their biological traits as the default position. That is, one does not choose one's belief as much as one, disregarding cosmetic surgery, does not choose his or her own stature or head shape. Of course, these thinkers recognize that beliefs change. But they argue that beliefs do not change as a result of optimization. Agents rather adopt any belief as long as, according to Simon (1976), it meets the minimum criterion of "satisficing." For these thinkers, stated broadly, routines and beliefs, rather than rational choice, should be the entry point of analysis because routines, and beliefs in general, cannot be chosen.

For them, routines and beliefs are not questioned or revised unless a hazard strikes. In this sense, Dewey's account anticipates Simon's notion of decision making as being

about procedures. Dewey developed the procedural view, which he called the "transactional view," with Bentley (Dewey and Bentley 1949). They specifically chose the term "transaction" to oppose the supposed dichotomy between fact and mental category. Such a dichotomy is behind the assumption that either fact precedes category (the standard rationality view), or that category precedes fact (the normative view). Dewey and Bentley stressed, however, that fact and category are involved in a union or a transaction. A host of new philosophers of science, of whom Kuhn (1970) is the most well-known, have also stressed this transactional union of categories, which Kuhn called the "matrix" or "paradigm," and empirical evidence. Dewey and Bentley were not, however, the first to articulate the philosophical approach that expresses the unity of categories and empirical facts. Before the likes of Kuhn, and pragmatism, there exists a long philosophical tradition that extends to Søren Kierkegaard and runs through the phenomenology of Edmund Husserl and the existentialism of Martin Heidegger. Although useful insights can be derived from examining this philosophical tradition, we will restrict our attention here to the procedural rationality (transactional) view as advanced by Dewey and Bentley, given its particular relevance to our focus on the procedural rationality of Simon.

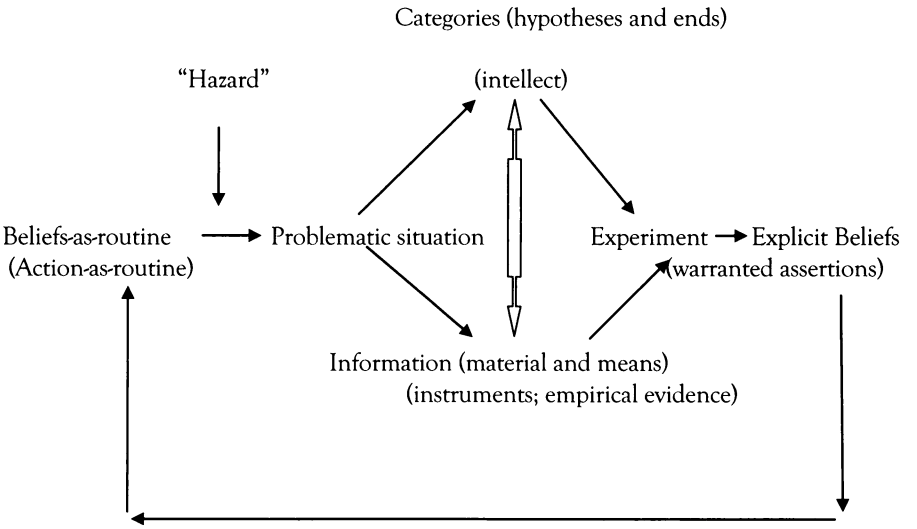
The transactional view regards categories and empirical evidence as facets of the same complex reality. Contrary to the standard rationality view, reality does not consist of empirical evidence, and categories are not a mere mirror image of this reality made up in the mind. On the other hand, contrary to the normative view, reality does not consist of categories, and empirical data is not a figment or a shadow of the categories. Rather, reality is the union (transaction) between categories and empirical evidence. The reality of a "tree" is the product of empirical evidence and how we classify a number of objects. There is no "tree" out there: instead, there are only particular individual examples of particular orders of plants.

As Figure 4, adopted from Frank Ryan's (2002) reconstruction of Dewey/Bentley's theory, shows, the transactional view postulates that the entry point should *neither* be the mind or intellect *nor* empirical facts — as if the two are separate. Rather, there is no entry point. The belief that appears as a routine appears as part of a circle that involves the union of the intellect and empirical data.

Beyond the Subject/Object Dichotomy

Aside from their differences, the standard rationality (interactional) view and the normative (self-actional) view both share the same Cartesian entry point that posits the subject (mind or intellect) as separate from the objects (sensations or empirical data) (Khalil 2004). It is true that, with everyday experiences, the mind reflects on sensations as if the two are distinguishable. For Dewey and Bentley, however, while the subject and object are distinguishable, they cannot really be separated in a radical way. Following Charles Peirce's critique of Cartesian dualism, Dewey and Bentley regard reflection or thinking as the aberration; it is the result of an exogenous shock that affects an unreflected routine or belief. For Peirce, Dewey and Bentley, the first approximation of organisms should not be thinking. This is contrary to the first approximation of the Cartesian view, which posits thinking as the foundation of action. For Peirce et al., the

Figure 4. The Procedural View of Beliefs



first approximation of organisms is rather action-as-routine, where the action is informed by more-or-less stable beliefs. That is, organisms are not born to think of and make conceptions that order the environment, but rather to act and make a living. In *Logic*, Dewey (1938, ch. 6) argues that agents have implicit beliefs consisting of "primary experience" or "havings." These "havings" are not the result of external reflection, but rather the result of successful problem-solving activities of a living, breathing organism.

So, beliefs involve the union (i.e., transaction) of subject and object in the form of the union between, respectively, categories and sense data. To clarify, the term "categories," for the transactional view, is not exclusively about conceptions of the world, but also about beliefs about the self. Likewise, the term "empirical evidence" is not simply about information concerning how the environment works, but also about available resources that define the ability of the self.

The proposed symbiosis of categories, which concerns *knowing*, and sense data, which concerns the *known*, is the bedrock of the transactional view. To posit *knowing* as prior to the *known*, as supposed by the normative view, or *vice versa*, as supposed by the standard rationality view, amounts to a primordial framework that invites the epistemological problem of the external environment, viz., the problem of how we know what we know about the environment. To avoid the problem of the external world, which has occupied Western philosophy at least starting with Descartes' work, Dewey and Bentley therefore rejected the separation of the mental from sensations, the categories from information, or, what they called, respectively, the knowing from the known.[5]

How Do Beliefs Change?

But how do beliefs change? This question is pertinent given that Dewey and Bentley, as well as advocates of Simon's procedural rationality, refuse to start the analysis with the intellect, knowing, awareness, or consciousness. For them, awareness or consciousness arises as a product rather than a starting point. As a product, awareness emerges when a routine process is confronted with a crisis or, what Dewey calls, a "problematic situation." For Bentley (1941), an "organism" is not just the body, but also whatever it uses to survive, such as the grass that supports it. Thus, while the body is delimited by the skin, fur, and whiskers, the organism should not be delimited by the boundary of its body. The organism need not be aware of the grass upon which its body stands as much as it need not be aware of its forelegs or its hair. Forelegs and hair are tools that are part of the production process as much as the grass. The organism becomes aware of its tools only when something goes wrong that disrupts the routine (i.e., when a problematic situation arises).

When a problematic situation arises, the implicit belief or routine becomes explicit (i.e., becomes the subject of reflection and scrutiny). In a problematic situation, the transactional union of knowing and the known breaks up into the intellect, on one hand, and empirical evidence, on the other. The agent then seeks new categories to solve the problematic situations or make sense of the new data. If the newly proposed category or belief (called "hypothesis" if carried out systematically by a scientist) stands the experimental test repeatedly, it becomes warranted. As such, and over time, the warranted belief becomes an implicit belief that informs the organism's actions-as-routine (see Figure 4). The agent would not reflect on the new routine unless another crisis disturbs the now settled, implicit belief.[6]

For the procedural rationality view, hazard disturbs the unreflected routine — irrespective of whether the routine concerns conceptions of patterns in the environment, or concerns convictions about self-ability that entails the undertaking of action. The procedural rationality approach expressly conflates external routines, based on conceptions, and routines of action, based on convictions. The procedural approach explicitly identifies "experience" as the entry point of theorizing. And experience, for the procedural approach, shapes the revision of all routines in the same manner — irrespective of whether the routine is about cognitive description of the environment or whether it is about technological action of shaping the environment (Khalil 2007). Both routines supposedly, according to the procedural view, are subject to the same mechanism of operation and change: They operate as the default and are re-assessed only when hazard strikes. The re-assessment takes the form of an alternative hypothesis, which, if it survives empirical testing, becomes the new routine. This means that, for the procedural view, an action to produce something, which involves beliefs about self-ability, and an action taken to inquire about the environment, which involves beliefs about the environment, are subjected to some quasi-Bayesian updating. It is quasi-Bayesian because, for the procedural rationality view, categories are not mirrors of empirical data to start with. So, they cannot be right or wrong. They can be only warranted or non-warranted. The procedural rationality view, similar to the normative view, recognizes that the categories are non-evidential. Therefore, when hazard strikes, which calls for new categories, the agent adopts

"satisficing" ones. For Simon, "satisficing" means that the agent adopts what is viable in the sense of meeting the criterion of some minimum requirement, such as whatever is needed to guarantee survival to the next day. So, agents do not optimize with regard to the use of information when they select categories and beliefs.

What About Conviction?

While conceptions about the environment can be more warranted than other conceptions, this cannot be the case with convictions. The environment does not develop as a result of an agent holding one conception rather than another. If one views a medical remedy in the loss frame, as opposed to the gain frame, it would not actually change the effectiveness of the remedy.

However, as stated earlier, self-ability does develop as a result of one's convictions. If one upholds a belief that one can paint and act on it when young, while shelving the belief that one can sing, the person would evolve as a painter. Such evolution is an irrevocable development arising from action (Khalil 2008). And such development makes it impossible to test whether the other conviction about singing is more warranted than the conviction about painting. The "evidence" (i.e., ability) has developed in an irrevocable manner. While mechanical systems, such as the motion of a billiard ball, can be reversed, biological ability moves in a direction that cannot be retraced.[7] If one starts singing at a later stage, the outcome cannot be used as evidence. The person at a later stage is not the same, younger person that started painting. Once one "tests" ability, the ability itself develops according to a process that cannot be revoked. The young person cannot be retrieved anew to test the belief that was not attempted. The ability has developed in an irrevocable way that leads to the creation of a new person.

This highlights the problem that faces the procedural rationality account, which is similar to the one that faces the normative view. Namely, both fail to distinguish between conceptions and convictions, which are, as we have already suggested above, distinguishable beyond just their respective objects (the environment and the self), even if both are non-empirically based beliefs. This difference becomes clear when we consider the difference between "shallow" and "deep" non-empirically based beliefs. For instance, the belief that the figure in Rubin's Vase is a goblet, as opposed to two profiles, is shallow in the sense that the agent can easily switch away to another belief. Definitely, if more details are added to the Rubin Vase, such as ornaments on the goblet, agents would tend to see the figure as a goblet. But insofar as the Rubin Vase remains free of details, the belief that it is a goblet is never stable. This is not the case with beliefs concerning one's assessment of self-ability. Beliefs about self-ability are usually deep. This is because, even after many failures and obstacles, agents usually persevere. In some cases, failures may even simply make the agent more determined to succeed.

With respect to empirical verification, beliefs about self-ability (convictions) and beliefs about figures in the environment (conceptions) are similar, namely, both are non-correctable, even with any further examination of empirical data. Nonetheless, they cannot be of the same kind of belief, given that one belief is shallow while the other is deep. So, the treatment of all non-empirically based beliefs as equivalently subject to warrantability, amounts to committing the second-degree Bayesian fallacy.

Conclusion

This paper commences with the distinction among four kinds of beliefs: confidence, conviction, perception, and conception. *Confidence* is a belief about the self where the object of the belief is a matter of scientific study. For instance, the belief that "I can stand the temptation of carrot cake" involves an object, the will to control temptations, which can be true or false because the object is not the subject of evolution as a result of the belief.

In contrast, *conviction*, is also a belief about the self – but here the object of the belief cannot be a matter of fact (i.e., the focus of scientific study). For instance, the belief that "I can climb the mountain" involves an object, the ability to climb, which cannot be true or false because the object is the subject of evolution as a result of the belief.

Perception, on the other hand, is a belief about the environment where the object is made up of pure evidential information, in other words, the information is context-free. For example, the belief that "the glass has 50 billion molecules of water" involves an object, molecules of water, which can be true or false because the object does not change with the belief.

In contrast, *conception* is also a belief about the environment – but here the object of the belief is rather couched by non-evidential information, the context. For instance, the belief that the "glass is half-full" involves an object, half-full, that cannot be true or false because it cannot be empirically verified that the glass is not half empty. That is, the "full" or "empty" words amount to adding a frame or context to the object that makes the object no longer the subject of truth or falsehood.

The paper, further, delineates the differences among three major classes of theories of beliefs. Although they differ from each other in radical ways, they generally fail to delineate the difference among the four kinds of beliefs. As a result, they commit, in different degrees, the Bayesian fallacy (i.e., the assumption that all beliefs can be updated via empirical investigation). Consequently, they fail to capture the uniqueness of convictions – the beliefs that are behind internal motivation, perseverance, and innovativeness. It is paramount importance to set convictions aside from the other beliefs because perseverance and innovations are behind entrepreneurial activity.

In entrepreneurial activity, the agent endures and does not give up for an internal motivation that involves the pursuit of an imagined goal. Such a goal involves a creative act, where a state of the world is invented. As such no probability distribution can be defined in relation to the imagined goal. A fuller exploration of the connection between convictions, internal motivations, and entrepreneurship is better left for another investigation.

Notes

1. That is, the identified three approaches, with their two degrees of the Bayesian fallacy, are committed to the modernist project (McCloskey 1994, 1998). The modernist project amounts to the ultimate belief that with honesty and hard work we can identify a uniform algorithm or set of criteria that can decipher for us what theories are more plausible, warranted, or true than other theories. In contrast, Nietzsche is not committed to the "truth business" of the modernist project. Put simply, Nietzsche runs the conflation of beliefs in the

opposite direction of the modernist project – he downgrades Bayesian and quasi-Bayesian beliefs to mere instances of convictions. Nietzsche treats all statements about the environment as ultimately not different from statements about self-ability.

2. To be clear, we can actually be gripped by anxiety and animal spirits even in a neoclassical world of quantifiable uncertainty as the one afforded by lotteries – as the certainty effect (Allais paradox) and the ambiguity effect (Ellsberg paradox) illustrate. The certainty effect can evolve into obsessive compulsive disorder (OCD) – even in a world of neoclassical uncertainty.
3. Charles Peirce puts forward this point sharply:

   > Suppose a being from some remote part of the universe, where the conditions of existence are inconceivably different from ours, to be presented with a United States Census Report – which is for us a mine of valuable inductions. . . . He begins, perhaps, by comparing the ratio of indebtedness to deaths by consumption in counties whose names begin with different letters of the alphabet. It is safe to say that he would find the ratio everywhere the same, and thus his inquiry would lead to nothing. . . . The stranger to this planet might go on for some time asking inductive questions that the Census would faithfully answer without learning anything except that certain conditions were independent of others. . . . Nature is a far vaster and less clearly arranged repertoire of facts than a census report; and if men had not come to it with special aptitudes for guessing right, it may well be doubted whether in the ten or twenty thousand years that they may have existed their greatest mind would have attained the amount of knowledge which is actually possessed by the lowest idiot. (Peirce 1931–1960, volume 2, 474-476; see also Buchler 1966; Peirce 1877).

4. Of course, as Fernández-Huerga (2008) shows, many heterodox institutionalist thinkers recognize the roles of initiative, tenacity, and creativity, which Simon's procedural rationality is too narrow to allow at first approximation. For instance, Brian Loasby (2001) is concerned with innovation and Geoffrey Hodgson (2003, 2004a, 2004b) is interested in how agency interacts with the social structures to create processes of change (see Dequech 2003, 2006). Further, evolutionary economists show how behavior in complex structures stimulates innovation and historical change (e.g., Dosi and Egidi 1991; Langlois 1986; Witt 2003). But the more fundamental point is what kind of consistent theory of belief formation one must have so that one can explain creativity easily. That is, we need a theory of action that can account, without *ad hoc* qualifications, for convictions and internal motivation – at the same stroke as it can account for the external motivation and the formation of the other kinds of beliefs. Put differently, while Simon's procedural rationality introduces the issue of habit/routine, and that agents, at first approximation, are habit-driven (and not maximizers), it might be appropriate only with respect to conception. That is, Simon's procedural rationality cannot be the primal theoretical tool needed to capture innovation. The tool is the distinction among beliefs, and how we cannot have a universal theory of belief – as if all beliefs are the same. Some beliefs, such as perception, can be updated via rationality theory; others can be best described by procedural rationality. But convictions, related to innovation, cannot be captured by any of the three theories of beliefs.
5. As Dewey (1977) argued in his famous 1905 essay, a thing does not exist in-itself: it can only exist in relation to something else. As he sums it up, "What *is* is what it is experienced *as*." What is experienced is the transaction of the categories (knowing) with the sensations (known). So, "reality" is nothing other than the product of the transaction. Here, Dewey is arguing for ontological pluralism – there is no one "thing," but rather a range of potential things as determined by the context of use. There is no entity that can be defined in isolation, apart from its field of transactions that include the knower. However, such a postulate should not be confused with the relativist or postmodernist position. For postmodernism, put simply, while things exist somewhere independently of us, they are impenetrable because we are locked away from them as a result of our senses, categories, and language (Bernstein 1983). Dewey denies that things exist independently of the categories in the first place.
6. In this manner, Dewey resolves to his satisfaction the problem of the external environment. For Dewey, a transaction amounts to the working of nature in the organism and the working of the organism in nature. That is, the organism is an extension of the laws of nature and physical nature is part of the organization of the organism. Dewey, therefore, avoids primordial conviction theories that oppose the organism (categories) and physical nature (sensations): categories and sensations are coexisting parts of the transaction or union of the organism and nature. The categories do not precede sensations, contrary to the self-actional view. And sensations do not precede categories, contrary to the interactional view.

7. Nicholas Georgescu-Roegen (1971, 196-200) has created a useful trichotomy between "reversible" motion, "irreversible" motion, and "irrevocable" motion. The motion of a billiard ball or a pendulum is reversible. The expansion of the universe or the motion of planets in the solar system is irreversible. While the motion cannot be reversed, it can in principle be reversed. On the other hand, for Georgescu-Roegen, influenced by Alfred Whitehead's process philosophy, organismic development or the evolution of species is irrevocable because such processes cannot be retraced, even in principle.

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