Abstract

Routines and instincts are similar in terms of function and structure: 1) With respect to function, they economize on scarce decision-making resources, such as cognitive faculties, by making actions, within limits, inflexible vis-à-vis fluctuating environmental stimuli. As inflexible patterns, they are units that can be transferred via inheritance or social learning. 2) With respect to structure, routines are simply the detailing of the more abstract underpinning instincts. If so, the similarity of routines and instincts amount to homology rather than simple analogy. So, instincts and routines are constituents of the same phenomenon. This behooves to have a single theory that explains their formation. But the literature largely lacks such a theory. Pointedly, natural selection theory, which can explain instincts, cannot explain routines because they arise during ontogeny. This paper proposes a solution, a radical one: the rational choice approach. The radical proposal can, first, show that routines arise on the basis of rational choice. If routines are ultimately hardened instincts, the proposal can, second, show that instincts arise also on the basis of rational choice. While this solution invites Lamarckism, it offers a single and simple account of routines and instincts—as account that meets Ockham’s razor.

Keywords: Rational Choice; Binary Operator; Binary Relator; Natural Selection; Lamarckianism; Ockham’s razor; Intelligence; Path Dependence; Spandrelism; Herbert Simon’s Procedural Rationality; Modularity; the Baldwin Effect; Proximate and Ultimate Reasons
**What is the Question?**

The phenomenon of routines presents an anomaly for natural selection theory. Routines, as defined here, are habits or what economists regard as units of “technology” or “institutions” that amount to *inflexible patterns of action*. Routines are inflexible in the sense that they, within limits, do not vary with the variations of environmental stimuli or incentives. On the other hand, routines are ontogenetic in the sense of being acquired throughout the life of the organism, i.e., they cannot be inherited via DNA-stored information. Each organism develops its own particular routines as its “specialization” becomes regularized patterns of action. In this sense, routines can be simple heuristics of regularized patterns of action that accompanies division of labor—where tasks are divided, systematized, and routinized.

Routines present an anomaly because such a definition does not distinguish routines from instincts—or at least how Konrad Lorenz [1957 (1937)] and Niko Tinbergen [1942, 1951] define instincts. Although their definitions differ somewhat, they generally regard instincts as also stimulated by the environment and amount to *fixed action patterns* that can be identified as units. As units, they are similar to biological tools such as the length of wings and sharpness of claws. As such, instincts are innate in the sense they are heritable [Lorenz, 1965]. This may entail that an instinct is phylogenetic onl in the sense that it is shared by a subset of the species, i.e., it need not be a universal trait that is shared by all members of the species, contrary to Stephen Stich’s [1975] view of innateness.

Why does the above definition of routines and instincts, which makes them indistinguishable, makes routines anomalous for natural selection theory? While natural
selection can explain the evolution of instincts through phylogeny, it cannot easily, even with the help of the Baldwin Effect as discussed below, explain the development of routines through ontogeny. Natural selection theories leave such a task to theories concerning the development of the organism (ontogeny). Natural selection theory expressly, at first approximation, makes ontogeny irrelevant to phylogeny, the evolution of species.

And here is the core of the anomaly facing natural selection theory. Given that instincts and routines are part of the same phenomenon, a theory that claims to explain instincts should also, with the same ease, explain routines. To restate the anomaly:

**The Anomaly:** While routines and instincts are ultimately indistinguishable, and hence demand a single theory, there are two different theories explaining them:

Natural selection explains instincts, while developmental-neural biology explains routines.

To solve the anomaly, this paper offers a radical solution:

**Radical Proposal:** The best explanation of routines is rational choice theory.

And given that routines are instincts in the making, rational choice theory explains also instincts. In this manner, we have a single theory (rational choice) that explains both routines and instincts—which fulfills Ockham’s razor. That is, the proposal grounds instincts no rational choice via routines.

The radical proposal is based on four premises:

1. **The Instinct/Routine Continuum Thesis:** This is an empirically based thesis that routines and instincts are identifiable units that regulate behavior and, further,
there is no fundamental difference between them despite the fact that one is inherited and the other is acquired during ontogeny;

2. **The Rationality of Routine Thesis**: This is also an empirically based thesis that rational choice theory is the best way to explain routines: Humans, as well as other organisms, develop routines in order to economize on scarce resources—consisting mainly of decision-making faculties and neural networks—which are needed to make decisions;

3. **Ockham’s Razor**: This is a methodological requirement that justifies the radical proposal. Namely, given that rational choice theory explains routines, and given that instincts are indistinguishable from routines, then rational choice theory must also explain the origin of instincts. In this manner, we have a single theory that can easily explain routines and instincts. This radical proposal entails, hence, two steps: first, rational choice explains routines and second, given that instincts are hardened routines, rational choice explains instincts;

4. **The Lamarckian Conjecture**: For the radical proposal to work, viz., the centrality of rational choice, a form of Lamarckian inheritance, at least at the epigenetic level, must be plausible.

This paper is organized, in the same order, to defend each premise. The goal of the paper is to show why the radical proposal solves the anomaly. The radical proposal has, though, many payoffs, one of them is discussed in the concluding section. It sheds light on the connection between proximate and ultimate reasons, such as the connection between the general tendency of
organisms to avoid pain and seek pleasure (proximate cause) and fitness (ultimate cause) [Mayr, 1982]. For neo-Darwinism, the connection is coincidental: The proximate cause arises randomly and, if fit, is confirmed via blind natural selection. For the radical proposal, the ultimate reason, via the routinization of response, gives origin to the proximate reason.

1. The Instinct/Routine Continuum Thesis

The anomaly of routines has taken many facets and versions throughout the history of theories concerning mind, behavior, and natural selection. This is not the place to review this rich history, but it is sufficient to mention one crucial turn. With the rise of behaviorism in the 1920s, most psychologists discarded the concept “instincts” [see Richards, 1987; Griffiths, 2009]. Once such psychologists embraced behaviorism, i.e., the primacy of the environment, there was no escape from the anomaly: As they wanted to explain behavior in terms of environmental stimuli, they no longer can explain instincts and, as usual in any research program, they called on themselves to abandon the concept altogether, as Zing Kuo’s [1921, 1922] argument illustrates. But, to start with, it was wrong to assume that instincts entail patterns of behavior that are divorced from environmental stimuli.¹

In any case, behaviorism has experienced a backlash, starting with Noam Chomsky’s [1957] breakthrough with his structuralist linguistics. Chomsky argues that children have innate ability

¹ Such a turn matches the way instinct was understood. Namely, it was understood as a pattern of behavior that is totally divorced from environmental cues. To wit, the early ethologists, Lorenz and Tinbergen, supposed that routines need the involvement of the environment, while instincts supposedly operate as a “vacuum activity”—i.e., even when the organism is deprived from any environmental stimulus. But this is a faulty conception of instincts. As Daniel Lehrman [1953] pointed out, instincts are very much in tune with the environment, to which they are suited. In fact, the later work of Tinbergen [1963] distanced itself from deprivation experiments, where instinctual behavior is
to organize utterances according to a grammar that cannot have been learned from scant environmental cues [see Chomsky, 1959]. And many child development psychologists, such as Susan Carey and Elizabeth Spelke [1996; see Medin and Atran, 1999, 2004; see Carruthers et al., 2005-9], find evidence that children, and adults, have an innate core knowledge about central categories such as objects, numbers, space, and agents. The work of Jean Piaget [1971; Millikan 1984] expresses the epitome of the backlash against behaviorism: Piaget finds children equipped innately with reasoning capabilities with respect to spatial, logical, and moral categories.\(^2\)

So, unless one is committed to orthodox versions of behaviorism, one cannot ignore an obvious observational fact: the ubiquity of instincts. As the term used here, “instincts” denote not merely what is recognized as innate capacity, but also what is recognized as “heritable” fixed patterns of action, as Lorenz and Tinbergen recognize. The trouble with the proposed usage is that microbiologists have failed to identify a specific gene for any particular innate/heritable behavior and, hence, instincts are most likely a by-product trait that arises from the constellation of genes as they interact with the environment. Insofar as these particular genes are heritable, it is appropriate to regard instincts as, in the final analysis, heritable behavior. So, the proposed juxtaposition of “routines” and “instincts” roughly corresponds to “acquired” and “inherited” behavior.

Although this paper juxtaposes routines and instincts, where one is acquired and the other is inherited, it subscribes to a growing literature in philosophy, developmental biology, and

\(^2\) Classical pragmatism, especially at the hands of John Dewey, is a critique of behaviorism: For Dewey [e.g., 1977; Dewey & Bentley, 1949], organisms do not simply respond to environmental stimuli; organisms rather have the disposition or innate capability to conceptualize the world by
psychology that disputes any radical divide between them [e.g., Oyama, 2000a, b; Oyama et al., 2001; Griffiths & Gray, 2005; Bateson, 1991; Moore, 2001; West et al., 1990; Marler & Slabbekoorn, 2004].

One can discern two versions of the instinct/routine continuity, which should not be seen as alternatives. While the first version stresses the structural similarity, the second version stresses the functional similarity. Concerning structural similarity, a routine is an additional layer that develops on top of a more fundamental structure, viz., a particular instinct. That is, routines are concrete reworking and detailing of abstract propensities, which are called instincts. Such reworking and detailing takes place as a result of the interaction of the organism with its environment. This view, which Kitcher [2001] calls the “interactionist consensus,” perceives behavior as the outcome of continuous gene-environment interaction—whereas the organism is the mediator [see Schaffner, 1998]. One need not view the organism as a passive mediator, though. In any case, the role of the genet- or organism-environment interaction is pivotal for the unfolding of the abstract (instinct) into the concrete (routine).

Given the structural similarity, the similarity between routines and instincts cannot be characterized as a superficial similarity (analogy). The similarity is rather a substantial one (homology). If so, one can predict that both (routines and instincts) employ the same motor structures and neural pathways, which can be empirically confirmed. Such an empirical confirmation cannot, given the scope of this paper, be undertaken here.

Concerning the functional similarity, instincts and routines perform the same function despite the fact that instincts are inherited while routines are acquired or imitated. As a
functional similarity, instincts and routines are binary units—either an action is an instinct or an action is a routine. Despite they are binary units, they lie along a continuum in the sense of their similar function, viz., the inflexibility of behavior. Obviously, the inherited units (instincts) are more inflexible than acquired ones (routines). Nonetheless, both would be inflexible in the face of fluctuating environmental stimuli, i.e., exhibit innateness that is opposite to deliberation, where behavior would vary according to circumstances [Khalil, 2009b].

Some theorists, such as Andre Ariew [1996], take innateness as relevant only to the environmental matrix, neglecting the role of instincts. To characterize the underpinning environment, Ariew borrows the metaphor of “developmental landscape” from Conrad Waddington [1957]. For Waddington, the landscape is underpinned by genetic “pegs,” which shows how organisms, even when they start from different peaks and hills, ultimately end up with the same phenotype. For Ariew, the landscape is rather underpinned by environmental “pegs,” where organisms end up with the same phenotypic behavior despite different starting points of environmental stimuli. Others [e.g., Griffiths & Machery, 2008] have shown that some changes in the environment may actually make a difference whether the organism has or does not have a trait. For Ariew, though, he wants to capture “innateness” in the sense of Chomsky, as deep structure of the brain, without any reference to the genome or instincts—and without reference to fluctuating environment. As others have clarified [e.g., Mallon & Weinberg, 2006], Ariew’s view does not rule out the relevance of the environment, but rather emphasizes a system of development that is “closed process invariant,” i.e., insensitive to changes in the environment. This insensitivity to environmental stimuli should prove relevant to the radical proposal, viz., the
centrality of rational choice theory for the explanation of routines and instincts.

These two versions are not alternative of each other. To wit this paper adopts both versions:

**Definition of Routines and Instincts:**

1. Routines and instincts are continuous because they are part of the same *structure*.

   Routines are further detailing or specialization of instincts that make up the foundation of the structure. For instance, a child is born with an abstract ability (instinct) to use the hands, whereas development channels such ability into concrete ability (routine) such as violin playing, typing, or striking nails with hammers. Likewise, while one is born with the abstract ability for language acquisition, development channels the ability into concrete ability (routine) of speaking French, or Japanese, or sign language;

2. Routines and instincts are continuous because they exhibit the same *function*.

   Both have the isomorphic feature of being, within limits, inflexible action patterns vis-à-vis environmental stimuli. Of course, there is a difference between instincts and routines—but it lies in the degree of the inflexibility. Instinctive behavior is more inelastic than routine behavior vis-à-vis the incentives. Further, as inflexible action patterns, they are units that can be transferred via inheritance or social learning.

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2. **The Rationality of Routines Thesis**
Routines and instincts are so intermingled that both exhibit “innateness”—i.e., the inflexibility of behavior in the face of fluctuating environmental stimuli. Given that innateness is common to both instincts and routines, there is no wonder that the term “innateness” has diverse definitions [Mameli & Bateson, 2006].

Given the common feature of innateness, routines and instincts are indistinguishable at least at prima facie level. Both express inflexible action patterns—but only within limits. Once an environmental stimulus rises above a threshold, the action pattern would not remain inflexible. It is granted that the threshold is higher for instincts than it is for routines. But insofar as this difference is a matter of degree, it behooves us to explain routines and instincts with a single approach, viz., the radical proposal concerning the centrality of rational choice theory.

2.1 What is Rational Choice?

The first task is to define rational choice theory:

**Rationality:** An entity is rational if it responds to a change in incentives (environmental stimuli) in the direction that enhances its non-myopic wellbeing, which economists call “utility” or “welfare” and which biologist call “fitness.”

This definition, first, includes only living organisms. It excludes self-guided machines, such as missiles and robots, since such entities do not pursue their own wellbeing. This definition, second, regards organisms engaged in myopic pursuits, i.e., organisms that succumb to temptations, as irrational. Such juxtaposition between the rational and irrational hinges on two
senses of rationality, what is called here the “consistency sense” and the “decision sense.” The consistency sense specifies that it is possible to identify what is the best (optimal) choice for one’s welfare or fitness—and a behavior that violates such a choice amounts to an irrational behavior. On the other hand, the decision sense stipulates that organisms may make irrational choices—i.e., a behavior need not be necessarily rational. To elaborate,

1) *Consistency Sense of Rationality*: This sense assures us that organisms can locate, at least theoretically, what is best for them. This is only possible if they have consistent objectives (preferences) as expressed in the objective function. If the objective function is inconsistent, the organism cannot identify what is best—and hence cannot be expected to choose it. The most important axioms that assure consistent objectives are transitivity, completeness, and local nonsatiation.

2) *Decision Sense of Rationality*: While organisms are able to locate what is best for them, they may not act accordingly. The decision sense of rationality assures us that organisms *actually* choose the optimal options. That is, they do not succumb to myopic options, i.e., become victims of weakness of will in the sense of falling into temptations. Such temptations include reckless behavior, overeating, under-saving, self-deception, regret, certainty effect, and many other suboptimal choices which are highlighted by behavioral decision theorists and behavioral economists [e.g., Kahneman & Tversky, 2000; Camerer *et al.*, 2004; see Khalil, 2011c]. With regard to nonhuman behavior, ethologists and behavioral psychologists have found evidence of the violation of the decision
sence of rationality [e.g., Marsh & Kacelnik, 2002].

Many economists, seizing on the findings of behavioral decision theorists, have challenged the relevance of rational choice theory. There challenges and debates cannot be discussed here, given the scope of this paper [see Khalil 2011a]. It is sufficient to mention that despite the behavioral findings, and in fact to make sense of them, and to make sense of self-imposed rules of behavior to avoid sub-optimal choices, we need rational choice theory [see Khalil, 2011a].

Aside from the challenges posed by the findings of behavioral decision theory, the above definition may invite diverse objections. To mention a few, the treatment of fitness and utility as equivalent might be controversial. There is no room in this paper to demonstrate the equivalence of fitness and utility [Khalil, 2010a]. Further, in case benefits are subject to objective risk or subjective risk (uncertainty), the organism must act on the basis of expected wellbeing/fitness, which also invites debates that cannot be discussed here.\(^3\) In addition, in case one’s environment involves strategic action, i.e., the choice of others influences one’s payoff, the organism’s environmental stimuli demands game theoretic analysis, an issue that is also ignored here.

Aside from these issues and complications, the above definition is very simple. An organism is sensitive to an incentive or a stimulus when the organism changes its behavior in response to a change of the relative ease of attaining good A (say, sunflower seed) instead of good B (say, banana). Also, an organism is alert to an incentive when the organism changes its behavior as a result of a change in the relative ease of attaining both goods—what economists

\(^3\) To capture expected wellbeing, most economists follow expected utility theory [von Neumann & Morgenstern, 1947], based on the “sure thing” axiom. The axiom, and other technicalities, entails that agents calculate expected utility by linear addition of utility under different states, adjusted according to the probability of each state, similar to how one computes expect value of a lottery. (The “sure thing” axiom is basically the intuitive idea that if one’s preference for option X is not affected with whether state A takes place or not, the agent should choose X before...
consider as an increase of the total budget. Of course, human and nonhuman organisms have to recognize the stimulus as conducive or pertinent to their welfare through learning. But given such learning, the change of what economists call “incentives” does not differ from what evolutionary biologists and psychologists call “environmental stimuli.”

Many theorists might find it surprising to equate “incentives” with “environmental stimuli.” It might be surprising because economists use the term “incentive” to indicate how flexible or elastic behavior is: Drivers, e.g., drive further away from bicyclists without helmets than bicyclists with helmets. The reason is that there would be less harm done in an accident if the bicyclist is wearing a helmet. In contrast, ethologists use the term “environmental stimuli” as the cue that prompts behavior, where such behavior stays stable irrespective of the degree of intensity of the cue.

But this difference is skin deep. Both the economists and evolutionary biologists want to account for the efficiency or the optimality of behavior, as shown below. Given that the economist starts with rational choice, it has to start with flexible behavior in response to environmental stimulus. In contrast, given that the biologist starts with natural selection, the heavy-weight instrument needed to account for optimality is done behind the scene: it is blind nature selection. This mean that the selected unit, the optimum genome, entails, at first approximation, inflexible behavior, i.e., behavior is a function of the gene rather than environmental fluctuations (incentives). At best, then environment is needed as a starter to prompt the fit inflexible behavior.

Put differently, given that the optimization problem in economics involves choice, the
behavior is presented at first approximation as sensitive to changes in the environment. And given that the optimization problem in evolutionary biology involves blind nature, the behavior is presented at first approximation as insensitive to changes in the environment. But, as shown below, despite the difference, both optimization problems generate the same product or outcome, viz., behavior that is optimally adapted to the environmental stimuli or incentives. While this outcome arises directly in rational choice theory, it arises indirectly in natural selection theory [see Khalil, 2009a].

There are, in addition, two challenges that need to be discussed given that they are directly pertinent to the radical proposal. One challenge relates to the question of how low-level intelligent organisms could be rational. The other challenge relates to the question of how organisms, that are bounded by historically deposited body plans, make optimal or rational choices. But before undertaking these two challenges, we need to expose how rational choice theory, as defined so far, can explain routines.

2.2 Routines and Efficiency

While the biological and psychological literature on routines is extensive, it hardly mentions rationality as the basis of routines. The literature usually discusses routines with respect to learning, especially, associative learning [e.g. Dickinson 1985]. A rodent, e.g., may learn to seek cover once it sees hawks in the sky. And such behavior may become routinized. But the learning need not necessarily imply routine formation. It may involve simple memory from experience. That is, associative learning does not necessarily entail routines. The issue of why some patterns of
behavior become routinized is orthogonal to the question of learning. This point forces us to focus on the origin of routines, independent of the issue of learning.

Further, the issue of learning is usually assumed as socially transmitted. This assumption was held by early ethologists, influenced by the work of Lorenz and Tinbergen [see Griffiths, 2004; Brigandt, 2005; Burkhardt, 2005]. For them, routines largely involve inter-group interaction, while instincts are followed without learning from others. So, experiments were set up to show whether courtship rituals can be performed even when the organism has never interacted with conspecifics. But this practice was later abandoned once theorists realized that instincts need environmental stimulus in order to come into action. Further, routines can develop on individual basis—i.e., social interaction is not a necessary precondition.

To understand routines, therefore, the entry point is neither learning per se nor social interaction in particular. Rather, the point of commencement should be decision making—where learning per se as well as socially transmitted learning enter at secondary and tertiary approximations. Once we understand the basis of decision making, it should light of how particular decisions become routinized during the life-time of the organism. So, the question is what kind of a problem that decisions, in general, try to solve? According to rational choice theory, the problem is how to use available resources, including time and abilities, in the most effective manner. This is the most impending problem because organisms face scarce resources, and efficiency is paramount for their success—as measured in terms of wellbeing or fitness.

As reviewed above, rational choice theory entails, in order to come up with the most effective solution to the scarcity problem, that organisms adjust their behavior in response to the
change of environmental stimuli (incentives). Plants, for instance, may change the direction of their growth in the presence of competitors in order to attain the maximum possible exposure to sunlight. Likewise, birds may change their choice of forests to harvest insects in response to changes in availability of resources [Tullock, 1971, 1994].

However, organisms do not change their behavior with any minute change in incentives. They usually develop routines or habits that are greatly inflexible. The inelasticity of behavior in the face of environmental fluctuations has been used as an argument, in the social science literature, to indicate the irrelevance, at first approximation, of the rational choice approach [e.g., Hodgson, 2001; Hodgson & Knudsen, 2004]. However, the phenomenon of routines rather vindicates the relevance of the rational choice approach. For instance, a tool, which may have diverse ways of usage, can become associated with only one method or behavior. Such inflexibility allows the organism to be free from re-calculation with each change of the stimuli (incentives) in order to figure out the best method of using the tool. Of course, there is a benefit from figuring out the best method. But if the cost at the margin, in terms of deliberation, exceeds the expected benefit, the agent finds it better to avoid deliberation and maintain a single method. The maintenance of a single method, i.e., attachment to a routine, allows some faculties to be free to conduct more fruitful activities. While the routine may not be the best response in each instance of change, it is on average the best response, i.e., optimal, if one takes into consideration the cost of re-calculating the action in each instance.

For instance, to use an example from our daily lives, such as taking the elevator, it might be beneficial for an employee, who uses the elevator daily to reach the fifth or sixth floor, to
figure out in each day whether it is more effective to take the stairs or take the elevator in each instance. But to become aware of all the factors, such as traffic at a specific time of the day, can become expensive. So, the employee usually finds it useful to adopt a single routine such as taking the stairs everyday. While the routine is optimal on average, it would seem suboptimal if one disregards the cost of re-calculation.

To note, the adopted routine may become reinforced by its own proximate stimulus, such as the pistachio color of the painted wall of the stairway. The agent, who might be neutral towards such a color, starts to develop an appreciation or a taste for it (the proximate cause) given that the routine is optimal in terms of utility or fitness (the ultimate cause). To wit, the ultimate cause may start to dim in the agent’s imagination as the agent becomes motivated to climb the stairs in order to enjoy the pistachio-colored walls.

In a famous experiment, G.R. Stephenson [1967] trained adult male and female rhesus monkeys to avoid eating bananas because as soon as one reaches for the bananas placed high on a ladder, the rest of the group is sprayed with cold water. In response, the group beats up any member who attempts to reach out for the bananas. The veteran monkeys teach new entrants the fear of eating banana. Such fear persists even when the original members of the group are fully replaced. The new group would not reach out for the bananas even when no one was sprayed with the cold water. Here, the routine of avoidance of bananas persisted because of the beating up, which acts as the proximate cause, when no monkey knows the ultimate cause, viz., the pain of the sprayed cold water. This shows that the proximate cause springs from the ultimate cause, which is contrary to neo-Darwinian theory as discussed in the concluding section.
Even when the ultimate cause becomes distant and dim, it does not mean it becomes irrelevant whereas the proximate cause (the routine) reigns supreme. Organisms may pay attention and start to disregard the proximate cause if it exceeds certain limits. Agents may suspend routines when the stimuli exceed a threshold. Let us re-visit the case of the employee who takes routinely the stairs to his or her office. The agent would review the routine if he or she repeatedly encounters delays as a result of congested stairway. The review and possible replacement of one routine by another confirms, again, the primacy of the rational choice approach in explaining routines.

One can extend the above analysis to explain the origins of heuristics, stereotyping, rules-of-thumb, and routines concerning perception. Heuristics include “buy an item when it is on sale or its price discounted,” which an agent may use when he or she is ignorant of the regular price. In most cases, the heuristic is correct: the discounted price is lower than the regular price. And it pays to follow the heuristic because, even when in some cases the discounted price is deceptive, in the long-term the agent saves energy and resources that are needed to investigate each case of advertisement. Likewise, in some cases, stereotyping is incorrect, as the case with optical illusion when rules of perception lead to the wrong perception. But, on average, stereotyping, similar to rules of perception, is effective in reaching judgment about the environment and, hence, economize on scarce resources of investigating and assessing each case [Rubinstein, 1998].

Another example, used again below with regards to instincts, is the feeding routine of the giant panda. To strip bamboo leaves, the panda uses its “thumb,” which is not actually a thumb
but rather an outgrowth of the wrist-bone [Gould, 1978; see Marciano & Khalil, 2012]. Panda, which lives in forests in northern China, has found an environment that is rich with bamboo. The cost of production of bamboo is high because, given its low nutritious value, means that the panda has to spend almost all of its working hours producing food. But in such forests, the panda does not face natural predators—and hence the cost of time is very low for the panda. That is, the cost of specializing on feeding on bamboos, relative to other activities, is very low. So, the panda chose in the long-distanced past optimally when it chose to specialize in feed on low-nutritious food. Such a choice has become a routine task given the general steadiness of the environmental incentives.

The feeding action of the panda, similar to the choice of the elevator over the stairs, becomes a routine when it becomes hard-wired in the neural structure of the brain. Such hard-wiring frees the active part of the brain to search and undertake more deliberative challenges—as noted as well by some psychologists and neuroscientists [Dickinson, 1985; Daw et al., 2005; Yin & Knowlton, 2006]. So, routines are born because it would be too costly to reinvent the wheel each time one wants to produce a product. That is, given that re-calculation is costly, i.e., cognitive effort is not free, decisions becomes hard-wired into routines and heuristics.

2.3 Distinguishing Binary Operators, Inputs, and Binary Relators

One may accept that the proposed rational choice theory of routines is plausible—but only to some organisms whose behavior is not highly scripted by historical or biological inheritance. Further, one may accept that the proposed rational choice theory of routines is plausible—but
only to some organisms that are highly intelligent. These two challenges of the generality of the rational choice approach need to be addressed because, as mentioned above, they are directly pertinent to the radical proposal.

To detail the two challenges,

1. how could we justify the relevance of rationality to explain behavior, when such behavior is greatly scripted by underpinning body plans or schemes that are well-entrenched as a result of historical inertia--what economists call “path dependency” and evolutionary biologists call “spandrelism”?

2. how could we justify the relevance of rationality to explain routines, when most organisms are, unlike humans and upper primates, not sufficiently intelligent to make decisions or are brainless?

This paper demonstrates that the first challenge, viz., the paramount of historical inheritance, arises from a serious conflation of the variety of technologies that are subject of choice, on one hand, with the underpinning scheme or body plan that must be assumed when the agent is optimizing, on the other.

This paper, in turn, demonstrates that the second challenge, viz., the relevance of intelligence, arises from a serious conflation of rationality, on one hand, with intelligence and other neuro-cognitive faculties, on the other [Khalil, 2010a].

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4 Economists do not usually discuss intelligence because, generally, they assume that agents simply comprehend their environment and behave in response to incentives. One exception is Roger Myerson [1991] who distinguishes intelligence from rationality. While humans in the market may not be intelligent, game theorists have to assume that a player in games which they construct is intelligent in the sense that “he knows everything that we [game theorists] know about the game and he can make any inferences about the situation that we can make” [Ibid. p. 4]. But the market environment, especially as demanded by “rational expectation” theorists in macroeconomics, can be complex and hence demand intelligence. As such, one can say that intelligence is a matter of degree, where game-theoretic settings might demand high degree of intelligence, while simple markets demand low degree of intelligence.
To expose the two conflations, i.e., to answer the two challenges, we need to elaborate on the structure of rational choice theory. In specific, we need to differentiate among four concepts that inhabit any decision theory:

1) Inputs (education, intelligence, technology/tool, resources)
2) Outputs (objectives)
3) Binary operator (technological scheme; functional transformer)
4) Binary relator (rationality)

These four concepts are represented in the following model of production:

$\{ (x_1, b_1, t_1) \ldots (x_j, b_j, t_j)^* \ldots (x_m, b_m, t_m) \mid C_j \} \xrightarrow{S_k} E_1 \ldots E^*_j \ldots E_n$

Concerning the input set, the agent faces three kinds of inputs:

1) A set of tools $T$ ($T = \{ t_1 \ldots t_j \ldots t_m \}$)
2) A set of behavior $B$ ($B = \{ b_1 \ldots b_j \ldots b_m \}$)
3) A set of ingredients $X$ ($X = (x_1, x_j \ldots x_m)$).

These inputs can be summed up as the set of constraints (C), which specifies the absolute level of each inputs, and hence specifies the relative ease (i.e., price) of using each input.

Concerning the output set, on the right-hand side, it consists of a set of ends $E$ ($E = \{ E_1 \ldots E^*_j \ldots E_n \}$).

The agent is limited by what can be called “binary operator” [Rai et al., 2012]. The binary
operator is a given technological scheme $S_k$, whereas $k$ denotes a particular scheme ($k=1, ..., p$), which is represented by the upper arrow above. The technological scheme specifies how the given inputs can be transformed into outputs.

Finally, the ranking of outputs and, correspondingly, inputs is achieved by what can be called “binary relator” [Ibid.], which is represented by the lower arrow above. The binary relator is the set of axioms of rationality that ensures consistent ranking of inputs/outputs—as specified by the consistency sense of rationality. This ranking specifies the optimum output, indicated by an asterisk (*), and the consequently the rational choice of inputs, also indicated by an asterisk, that guarantees the optimum output, given the constraints and the binary operator.

Given the inputs and the technological scheme, the agent finds a particular combination of inputs, marked by an asterisk, to produce the best (optimal) end, also marked by an asterisk. When the agent chooses the inputs that maximize the output, the agent then fulfills the decision sense of rationality, as discussed above.

Given these four concepts, we are now ready to avoid the two conflations, i.e., answer the two challenges that face the proposed rational theory of routines. Namely, to avoid the conflations, we need to make these two distinctions, elaborated in the following subsections:

1) technology-as-binary-operator versus technology-as-input

2) intelligence (technology-as-input) versus Rationality (binary relator)

2.4 First Challenge: Routines and Path Dependence

Concerning the first distinction, the set of technologies that make up the input set differs from the
technological scheme (binary operator) represented by the upper arrow above. While the agent can choose the best tool that inhabits the input set, such choice is restricted or, better phrased, informed by an underpinning technological scheme that cannot be chosen. The scheme is not under choice because it transforms inputs into outputs, and there must be a transformer that cannot be chosen simultaneously with the choice of what is being transformed, i.e., the tools-as-inputs.

However, the technological scheme is nothing but a higher-grade tool. The scheme is simply an older tool that has defined consequent choices. At some point in the past, the scheme was simply a tool that was chosen among many. And it is possible, if environmental constraints justify it, for the scheme to become the subject of choice again. But, at any particular choice, there must be a deeper scheme, viz., a binary operator, which cannot be the subject of choice. This should not mean that the agent does not make choices with regard to the input set.

The distinction between the binary operator, which cannot be chosen, and the input set, which can be the subject of choice, shows the nature of optimization. Namely, optimization by definition cannot involve the choice of the binary operator. Otherwise, one would be involved in what can be called the “global ideal”—where optimization is supposedly free from its own history in the sense of nature or agents selecting alternatives in disregard of the cost of replacement of historically given scheme with another scheme.

The exposure of the bogus “global ideal” undermines the ground upon which the critics of rational choice theory stand. The critics usually point out that choice is greatly limited—if not absent at first approximation. The limit to optimization, as defined by the binary operator,
however, is never denied by the promoters of rational choice theory insofar as agents cannot choose the binary operator. But such a limit does not mean that agents make no choices—since agents can still choose elements that make up the input set.

Critics of natural selection usually use the phenomenon of spandrelism to buttress their thesis, viz., natural selection cannot modify the scheme according to new functions. Critics of rational choice theory, as applied to routines or what economists generally call “institutions,” usually use the phenomenon of path dependence to buttress a similar thesis. These critics in both literature ultimately fail to realize that optimization, by definition, cannot and should not involve the choice of scheme (binary operator)—and is limited to the choice of traits or technology/institutions that make up the input set.

To elaborate, one can identify two bodies of literature—path dependency and habituation—which complement each other in support of the criticism of optimization theory in general, and the criticism of optimization with regard to routines in particular [see Khalil 2012]. What is interesting, each body of literature exists, independently, in both disciplines of economics and evolutionary biology:

1. *Path-Dependency/Spandrelism:*

1.a *Economics:* This body of literature started with the QWERTY typewriter example highlighted by Paul David [1985, 2001]. He argued that the QWERTY typewriter technology had a good reason of why it was chosen over the faster Dvorak Simplified Keyboard (DSK). The DSK technology made the jamming of arms more frequent than the case with the QWERTY technology. With the advent of ball-point, where the
jamming of arms is no longer an issue, DSK is superior to QWERTY. Nonetheless, QWERTY persisted as a result of path dependence. It became very hard to replace QWERTY with the superior DSK.

1.b Evolutionary Biology: Spandrelism in evolutionary biology parallels the notion of path dependency in economics. According to Stephen Jay Gould and Richard Lewontin [1979], certain traits, as analogically represented by spandrels in architecture, are chosen not because of efficiency but rather because of already existing structures (binary operators). Gould [1978] uses the panda’s “thumb” to illustrate the point: While it is a clumsy wrist bone that is inferior to a proper thumb, it is chosen because of already existing hand plan (binary operators). Gould [1987] even appeals to QWERTY to talk about the supposed suboptimality of the evolution of human technology.

2. Habituation/Modularity:

2.a Economics: This body of literature started with Herbert Simon’s [1976] notion of “procedural rationality”—which he coined earlier “bounded rationality” [Simon, 1957]. According to Simon, behavior is habituated in the sense that it cannot be optimal à la standard theory which he calls “substantive rationality.” For Simon, optimal decisions are too cumbersome, if not impossible, to compute. Agents are rather prisoners of their own habits: Agents are more-or-less content with their default habits as long as they are functional in the sense of satisfying some minimal demands. So, routines, similar to habits, cannot originate from rational choice—as proposed here.
2.b Evolutionary Biology: Modularity in evolutionary biology parallels the habituation notion of Simon [see Callebaut & Rasskin-Gutman, 2005]. Modularity has been employed to support the EvoDevo approach, [Matsuda, 1987; Hall et al., 2004]. Aside from this link, according to the advocates of modularity, agents act according to viable or functional rules-of-thumb, where each rule or routine is suited particularly to the content of the act. That is, there is no general principle, such as rationality, that can explain routines in general. Routines are rather independent modulares where each is content- or task-specific.

Let us discuss the first body of literature, viz., the path dependency or spandrelism thesis. Let us suppose, along with Paul and Gould, that path-dependent technologies or traits (from spandrels, panda’s “thumb,” to QWERTY) are inferior to alternative technologies or traits. However, as elaborated elsewhere [Khalil, 2012; Marciano & Khalil, 2012] and noted by others in the economics literature [Liebowitz & Margolis, 1990; Lewin, 2002] and in the evolutionary biology literature [Orzack & Sober, 1994, 2001; Potochnik, 2009], the superiority of a trait/technology does not necessarily entail that existing path-dependent technologies/traits are inefficient or tolerated on irrational grounds. It might be the case that the switch cost (what economists call “transaction cost”) to the superior alternative is too high to justify the switch. For instance, for humans to use a single universal language is superior to the current state of Bable. However, the transaction cost of switching might be excessive relative to the expected future benefits of a universal language. So, the persistence of existing routines, traits, and technology, in the face of superior ones, does not mean the irrelevance of rational choice, in
particular in relation to routines. To the contrary, path dependency or historical inertia confirms, rather than disproves, the relevance of optimization once we take into account the transaction cost of switching.

Put differently, path dependency shows that some schemes, even they are inferior to existing alternatives, cannot be the subject of choice because it would be inefficient to subject them to choice. Such schemes are better left untouched, and rather used as binary operators that aid in transforming the inputs set into the output set. As discussed above, the fact that the binary operator is left untouched, seen as the product of inertia or path dependence, does not mean that the agent is not involved in rational decision making or, in the case of natural selection, in optimization selection. To wit, optimization calculus takes place at two levels. First, insofar as the binary operators are left untouched because of enormous transaction cost, the optimization calculus is in operation. Second, the fact that the agent does not question the binary operator does not mean the irrelevance of rational choice. The agent, or nature, can still subject the elements of the input set to choice in order to select the optimal bundle.

In the face of such a response, critics who use path dependency as a critique of the optimization explanation (in particular, rational choice) of technology, such as Paul [2001], modify their argument. They advance the view that agents may cling to a binary operator even when the transaction cost is lower than the expected benefits. And agents cling to such a binary operator supposedly as a result of habituation. But such a view is not only a critique of optimization with respect to technology, it is rather a critique of whole rational choice (or optimization, in general) approach.
The habituation view supposes that agents, at first approximation, act according to habits. This view invokes the second body of literature, viz., Simon’s procedural rationality or, in biology, modularity. According to Simon [see Felin & Foss, 2010; Khalil, 2007, 2011b], agents continue proceeding according to a pattern of behavior or routine just simply because it is the de facto case [see also Leibenstein, 1987; Gigerenzer & Selten, 2002]. According to this habituation view, routines or institution-governed behavior can never be chosen optimally. Agents would replace their routines with alternative routines only when a crisis erupts or a shock takes place. In this case, the chosen alternative is not the optimal one, which is impossible to compute, but rather the first one to encounter that meets a minimal set of demands.

The phenomenon of routines, insofar as they are supposed to be the primitives, challenge the rational choice approach, according to the classic work of Richard Nelson and Sydney Winter [1982] and others [Becker, 2005; Becker et al., 2006; Hodgson & Knudsen, 2004; Hodgson, 2008]. However, not all scholars of routines regard routines as, at first approximation, a pattern of behavior as well as a program that generates different patterns of behavior depending on the cue. As a pattern of behavior, a routine is a skill or embodied human capital that is analogous to a phenotype. As a program that generates behavior, a routine is like genotype. Nooteboom [2000] advances the definition of routine as a genotype and calls it a “script,” a term which he borrows from Shank and Abelson [1977]. For Nooteboom, individuals and firms act according to a script, ready to switch between patterns of behavior depending on the cue. Likewise, Hodgson and Knudsen [2004] favor the definition of routines as genotypes. Hodgson [2008] actually finds it problematic to hold both
unrelated to optimization. For instance, scholars of organizations and corporate strategies [e.g., Pentland & Rueter, 1994; Feldman & Pentland, 2003] show that organizations are characterized by routinized tasks, but such routinized tasks are subject to evaluation and change in light of changes in environmental conditions.

In any case, the critique of a rational theory of routines is ultimately a critique of rational choice theory concerning behavior per se—i.e., it is not merely a critique of rational theory of routines. That is, Simon’s theory of procedural rationality is an alternative of rational theory per se. So, is Simon’s procedural rationality or modularity warranted? If warranted, it can be the unifying theory of both routines and instincts—and hence there would be no need for the radical proposal. That is, Simon’s procedural rationality, insofar as it can explain routines, can act as well as the theory of instincts.

At a close scrutiny, Simon’s theory cannot replace rational choice theory because it ultimately relies on rational choice theory [see Khalil, 2012]. If agents are ready to shed away a routine in a crisis, it means that they respond to incentives. Agents, further, seem to search longer for an alternative routine the greater are the consequences. For instance, agents search for a house longer than a shirt. So, again, agents seem to be alert to incentives. Ultimately, rational choice definitions of routines, i.e., as genotype and phenotype. Vromen [2010] finds no problem in upholding both definitions of routines in light of the fact that firms are multi-leveled: At the level of interactions among employees, routines appear as a pattern of behavior or phenotype. At the level of the firm, where the firm can switch among routines, the routine appears as a program or as a genotype.
can be cumbersome, and maybe impossible to compute, as Simon registers, if one presumes that optimization is about the “global ideal” where everything is up for choice. But as discussed above, optimization must assume binary operators as given and, hence, need not be as cumbersome as Simon presumes.

Put succinctly, the first challenge, viz., path dependency or spandrelism undermines rational choice or optimization in general, fails. It is ultimately based on the confusion between technology/trait as a binary operator with technology/trait as an input. Once the difference is made, it should be easy to conceive that the agent (or nature) selects optimally a behavior, even when the binary operator is not selected. The optimally selected behavior, overtime and again for efficiency reasons, may become gradually ossified into routines.

2.5 Second Challenge: Intelligence vs. Rationality

Thus, the first challenge does not stand close scrutiny. What about the second challenge, viz., how could we assert that behavior is chosen rationally, where the behavior can develop into a routine, when the agent is of low-intelligence or does not even have a brain as the case with plants? This type of challenge confuses intelligence with rationality—or, more broadly, confuses trait-as-input (intelligence) with the binary relator (rationality).

Let us first define intelligence. Most recent research on intelligence focuses on three areas: individual differences in intelligence, the relative role of genetics and environment in determining intelligence, and the socio-economic consequences of the faculty of intelligence [Deary, 2012]. The latter area concerns us because it implicitly recognizes intelligence as a tool
or capital that enters as an input in the production process. While intelligence has genetic basis, it can be harnessed and refined through education and experience like any other faculty or capital input. As a tool or a capital input, intelligence is a member of the input set—which sets it aside from rationality that acts as a binary relator. This highlights that while intelligence varies across individuals and populations, this does not mean that rationality must likewise vary.

To express the difference intuitively, let us first define intelligence:

**Intelligence:** Intelligence is, broadly, a conglomerate of different cognitive faculties or skills. But in the narrow sense, it can be considered a single technology/tool. Similar to all tools, it is costly to develop. But the payoff is speedy processing of information concerning the other inputs. Therefore, a marginal increase of intelligence has two ramifications: First, concerning the marginal benefit, it makes the agent’s input-output interconnection faster to compute than otherwise. Second, concerning the marginal cost, it increases the effort of the agent to attain and maintain intelligence. If the net result is an expansion of the input set, the agent (or nature) should invest in the extra intelligence. Otherwise, viz., if the input set would contract, the agent should avoid investing in the extra intelligence.

That is, it may not pay to acquire extra intelligence if the cost exceeds the expected benefit at the margin. If organism M has a lower intelligence than organism F, M cannot compute as fast as F the ramifications of a decision. But M can be more fit than F if the cost of the extra intelligence does not justify the benefit.
Let us say that a low-intelligent agent can calculate ramifications of a decision to the 7th iterations, while a high-intelligent agent can calculate ramifications to the 10th iteration, given the same period of time. This is the case simply because the more intelligent agent has a greater faculty of comprehending and processing information. This does not mean that the slower agent is less rational. So, if the slower agent chooses an unhealthy diet because of failing to compute a greater extent of ramifications, it does not mean that the agent’s choice is irrational in comparison to the more intelligent (faster) agent.

In contrast, rationality assures us, following the two senses mentioned above, two results. First, the ranking of options in the input and output sets are consistent. Second, as the lower arrow in the above scheme suggests, the agent actually chooses the proper inputs (with asterisk) to generate the optimal output.

So, two organisms can have different degrees of intelligence, given their different niches, without having any ramifications with respect to their rationality. In fact, we use the same rational reasoning (or optimization) to explain why we have a variety of intelligence skills [Khalil, 2011d]. While one organism may have a brain, and the other may not, both are equal in rationality—given the definition of rationality as simply choosing the best given one’s abilities and inputs. To express it in neo-Darwinian terms, while snails and humans differ in terms of intelligence, both are equal in terms of optimal fitness—i.e., what the rationality principles demand [Khalil, 2011e].

So, to state that routines have their origin in rational choice should not exclude low-intelligent or brainless organisms. Rationality and intelligence are as far apart as the binary
relator stands apart from the elements of the input set which the binary relator attempts to rank. That is, rational theory of routines, similar to natural selection theory, need not be restricted to high-intelligence organisms.

3. Ockham’s Razor

So far, we have established two out of the four premises stated at the outset of this paper. The two premises are:

1. Routines are indistinguishable from instincts;
2. Rational choice theory is the only warranted option available to explain routines.

Given these two premises, we can conclude:

**Conclusion:** Rational choice theory must be the theory of instincts.

In this manner, instincts would be simply more rigid or hardened routines. And routines develop into instincts for the same reason that behavior develops into routines. With the rise of instincts, cognitive resources are economized to deal with other challenges.

The only difference is that such rigid patterns of behavior are inherited while routines develop during ontogeny. Of course, this difference invokes some form of Lamarckism, which is discussed below.

But what justifies the conclusion—viz., a rational theory of instincts? The justification is Ockham’s razor: It is more desirable to have a single theory (the radical proposal) to explain the same phenomenon (routines/instincts) than to have two different theories to explain the same phenomenon. The two theories in our case are natural selection, used usually to explain instincts,
and modularity theory, learning, or the proposed rational choice theory, used to explain routines.

Ockhams’s razor is behind the success of Newton’s law of gravity—at least according to Adam Smith [1980; see Khalil, 1989]. What makes Newton’s law so attractive is that it provides a single account for two phenomena, terrestrial motion and celestial motion, which were supposed to be different. For Smith, scientific theories that are simple, but still able to account for the greatest phenomenon, afford an aesthetic enjoyment.

To illustrate the radical proposal, viz., liking instincts to rational choice via routines, let us revisit the example of the panda’s “thumb.” As argued earlier, the stripping of bamboo leaves is a rational choice given the low-cost of time for the pandas afforded by the absence of predators. And such stripping can easily evolve into routine during ontogeny in order to dedicate other faculties for new challenges. After thousands of generations of stripping bamboo leaves, the radical proposal predicts that a new-born panda would be more agile at stripping bamboo leaves than would be another new-born of different phylogeny that even has an opposable thumb that is less clumsy than panda’s “thumb.” A new-born chimpanzee, e.g., born with the opposable thumb, should be better equipped anatomically to strip bamboo leaves than a new-born panda. Thus, the observation that a new-born chimpanzee, at same developmental stage as the new-born panda, is worse at stripping bamboo would confirm the prediction of the radical proposal.6

If we reject the radical proposal, we would be forced to adopt a theory for routines that differs from natural selection theory, which can explain instincts. Natural selection simply

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6 If the new-born chimpanzee, however, is better at the task than the new-born panda, may not be a decisive falsification of the radical proposal. One can attribute such an observation to the fact that the superior tool used by the chimpanzee is effective enough to offset deficiency of lacking the instinct which the panda has.
cannot account for routines. Given the instinct/routine continuum thesis, such a state of affair fails to meet Ockham’s razor.

One may suppose that the Baldwin Effect can save the day. Namely, natural selection theory can explain routines and, hence, there would be no need to invoke rational choice à la the radical proposal. According to Mark Baldwin [1896], if members of the population explore a new environment, the explorers might stumble into a new condition that favors them over the non-explorers that lack the desired genetic makeup. The explorers have advantage over the others and, hence, their offspring, that carries their desired genetic makeup, would become more representative in the population. The explorer group will be able to develop the particular routines needed for the new condition faster than the non-explorer group.

The Baldwin Effect basically pays attention to the possibility that organisms seek out new environmental conditions. However, it is not a theory of routines, where routines are understood as ontogeny. The Baldwin Effect cannot explain why, the explorer group, whose members have same genetic makeup, can have diverse routines. That is, it cannot explain, by using natural selection, explain why a particular organism develops a particular routine as opposed to another routine developed by another organisms with the same genetic makeup. The Baldwin Effect, as Daniel Dennett [2003] argues, is consistent with the adaptationist orthodoxy. It is a natural selection theory with a twist—where the twist is how a tendency or proclivity can become validated—where such a twist is not pertinent to solving the routine anomaly posted at the outset.

Another attempt to use natural selection to explain routines, and hence preserve Ockham’s razor, is to extend Richard Dawkins’ [1989] notion of “memes” to routines. Memes
are supposed to parallel genes at the cultural level. So, a population can have a variety of routines, seen as cultural norms, where nature can select organisms with the fittest routines. Unlike genes, cultural norms or routines are replicated via imitation. There is no need to appeal to rational choice theory to account for varied routines. However, one shortcoming of this account is that organisms do not adopt routines randomly to start with. They rather develop according to the specific experience of each organism, i.e., throughout ontogeny.

So, to solve the routine anomaly, the only option is the radical proposal. However, there is one hurdle that faces the radical proposal: it invites the Lamarckian conjecture about the inheritance of acquired characteristics.

4. The Lamarckian Conjecture
Lamarck [1984] formulated two theses concerning the origins of acquired characteristics. First, a vitalistic force is behind the increasing complexity of organisms throughout evolution. Such force is evident in the inner tendency of tissues to become more elaborate and complex. Second, tools or organs that are neglected tend to diminish, while tools or organs that are used tend to flourish and develop.

Unlike the first thesis, the second thesis is indisputable which was also stressed by Charles Darwin [1964, pp. 134-7, 454-5, 479-80]. What concerns us here is an extension of the second thesis. Namely, Lamarck articulated the belief that the developed trait can be transmitted to the offspring via genetic inheritance (and not simply through social learning or cultural inheritance). Actually, Lamarck’s belief was not limited to him, but rather was a widespread
belief among biologists of his day. What is important to note is that the Lamarckian belief concerns traits that had gone through experience to mature, flourish, and develop during ontogeny. That is, the belief is not mainly about traits that have simply risen as a result of external shocks, such as limps that have been severed or maimed as a result of accidents. This is an important distinction insofar as identifying a possible mechanism, discussed below, for the Lamarckian belief.

There have been some claims of evidence in support of the Lamarckian belief, but only to be disqualified for one reason or another, including the mishandling of data. This history cannot be reviewed here. It is sufficient to state that Darwin [1988] did not exclude the inheritance of acquired characteristics and even proposed a possible mechanism. Given that acquired characteristics modify somatic cells, Darwin conjectured that such cells generate “gemmules” or “pangenes” in the body. Such molecules travel (not necessarily through the blood stream) to the germ cells. After sufficient and elongated period of accumulation of such molecules, the germ cells are modified accordingly, which affords the inheritance of the acquired characteristics.

A recent confirmation of the Lamarckian belief is the work of John Cairns and his co-workers [Cairns et al., 1988] on a mutated strain of E. coli bacteria that cannot consume sugar lactose. However, once such mutated bacteria are placed in a stressful environment, i.e., made only of sugar lactose, the bacteria largely learn and develops the ability to digest the sugar. And the parent cells were able to pass on the new gene to the next generation. Carins [see Cairns & Foster, 2003] later distanced himself from the Lamarckian interpretation of the findings.

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7 Arthur Koestler [1971] discusses an interesting and famous case, the experiments of Paul Kammerer on toads, where the empirical evidence was found to be improper, if not fraudulent. Koestler argues that the evidence was actually tempered with intentionally in order to defame Kammerer.
Nonetheless, it is indisputable that the bacteria mutates more frequently than what would be the case if not under environmental stress. Such an increase in the rate of mutation, even if not directed in one direction or another for expected benefit, still involves a change of behavior in light of environmental stimuli (stress). This discovery has emboldened the proponents of Lamarckism [see Tauber, 1991].

But such support of the Lamarckian belief is limited to unicellular organisms, which is unproblematic. In unicellular organisms, somatic acquired characteristics can be carried by the germ cells since they are one and the same. In contrast, multicellular organisms present a challenge: How can changes to the somatic cells influence the germ cells, i.e., penetrate the Weismann barrier—the supposition of an iron wall separating the germ line from somatic changes?

The conjecture of E.J. Steele and his co-workers [Steele, 1981; Steele et al., 1998; Jablonka & Lamb, 1995] can be of interest in this regard. Steele and his co-workers offer a mechanism that resembles the pangenesis hypothesis of Darwin. They propose that novel genes are generated in the somatic B-cells, which are transported by retroviruses via the blood stream to the germ cells. The newly acquired genes can then retrofect the genes of the germ cells.

Actually, the radical proposal can sail without the total collapse of the Weismann barrier. The radical proposal is viable with the idea of epigenetic inheritance at the level of multi-cellular organisms, which is gaining empirical support. As Evan Charney [2012] shows, recent discoveries concerning the role of the epigenome in DNA expressivity are challenging the dogma that the DNA is the ultimate template of heredity because the epigenome, which is the
subject of diverse environmental influences, can be inherited via the germline.

For instance, a recent study of the foraging behavior of chicken demonstrate that chicken subjected to stress with regard to the regular availability of food have adopted particular behavioral patterns. Such patterns showed up in future generation of chicken via mechanisms other than learning [Nätt et al., 2009]. A similar epigenetic effect was shown with regard to obesity in rats. A father rat exposed to high-fat-diet causes the female offspring to have B-cell dysfunctions that induces obesity [Ng et al., 2010; see also Lumey et al., 1995].

Many evolutionary biologists who object to DNA-based Lamarckian mechanism recognize epigenetic inheritance of acquired characteristics [e.g., Haig, 2007]. Although neo-Darwinists usually consider epigenetic inheritance to be a feature of phenotypic plasticity, it is technically Lamarckian [see Jablonka & Lamb, 2005]. Germ cells include hereditary elements, such as chromatin marks, other than the DNA. Such elements regulate gene expression. Insofar as these elements can be modified in response to the environment, and they are inherited, the acquired characteristics are inherited. Such inheritance might not be long-lasting, given that the genes have not changed. Nonetheless, if our focus is on phenotypic changes, the long-reach of the environment in actively—rather than passively as supposed by natural selection—shaping the organism is what is needed to buttress the Lamarckian conjecture. Analogously, if a country has a law, even when written in the constitution, and if the country’s actual practices deviate from such a law, the country would have evolved as expressed by the practices, even when the dead letter of law has not been explicitly nullified.
5. Conclusion

This paper commences with the routine anomaly: While routines and instincts are moments of the same phenomenon, there is no single theory that can easily account for both as moments of the same phenomenon. We rather have two different theories: One, usually natural selection, accounts for instincts while another, whatever action-based theory, accounts for routines.

To solve the anomaly, this paper advances a radical proposal. Namely, rational choice theory should be the basis of explaining routines and, given the instinct/routine continuum thesis, should be the basis of explaining instincts.

One great payoff of the radical proposal is that the suitability of proximate and ultimate reasons of behavior, the major concern of any evolutionary theory, is not accidental. For neo-Darwinism [e.g., Mayr, 1982], the suitability is supposedly accidental: When an organism responds to a stimulus such as the avoidance of pain (proximate reason), such a response is a trait that has risen stochastically and was blindly selected by nature since such selection increases fitness (ultimate causation). For instance, why do smelly fish smell “bad”? For neo-Darwinism, we can have a number of traits in the population, where many organisms enjoy the smell of the smelly (rotten) fish while others, accidentally, do not. The organisms that enjoy the smelly fish would get sick upon eating the rotten fish and die before being able to reproduce, while the organisms that dislike the smelly fish survive and have a greater chance to reproduce their own trait. Thus, for neo-Darwinism, the trait of smell towards fish (proximate reason) and fitness (ultimate reason) have unrelated origins.

In contrast, for the radical proposal, the proximate and ultimate reasons are strongly
related, as Adam Smith actually argues [see Khalil, 2000; Haig, 2011]: Organisms start with a
smell trait that is neutral to all fish, fresh and rotten. When they eat smelly fish, and they get
stomach ache, organisms start to associate the stomach pain with the smell. The transference of
the stomach pain to the sense of smell, where the smell itself becomes painful (repulsive)
amounts to the formation of a routine, i.e., a rational routine that ensures an efficient way to
increase fitness (health). As such, the proximate reason (sense of smell) intimately arises from
the ultimate reason (fitness).

This paper first reviews rational choice theory and its many challenges. Rational choice
is ultimately the most warranted theory to explain behavior. Such behavior becomes ossified into
routines if the environmental conditions continue to be stable. We, again, need rational choice
theory (or optimization in general) to account for the ossification: If the environment is more-or-
less stable, the agent does need to invent the wheel with each encounter. The agent can rather
rely on biological-based routinized response to the stable stimuli in order to economize on
cognitive resources that can be used for other challenges. Such routines can become, over
evolutionary time, instincts for the same reason, i.e., rational choice reasoning: The hardening of
routines into instincts further frees cognitive resources to undertake other challenges.

This solution is radical for many reasons. First, insofar the proposal concerns routines, it
entails that all organisms, and not only humans, behave according to cost-benefit calculation.
This amounts to de-throning humans from any special position in nature. It challenges
entrenched anthropocentric views of the human condition. Second, insofar as the proposal
concerns instincts, it invites the Lamarckian conjecture.
Third, and of most importance, the radical proposal entails that behavior, experience, decision, or action should be the starting point of understanding the evolution of routines and instincts. That is, the starting point should not be the stochastic mutation of genes—as if genes are the ultimate primitives. Genes are, at best, second-order mechanisms that amount, analogously, to memory devices, while the first-order mechanisms are reserved to decision makers who calculate cost and benefit in order to determine the optimal behavior—and consequently explain the rise of routines and instincts. Memory devices in the brain provide hard-wired networks to support optimal behavior, which appear as routinized behavior. Genes, likewise, are “memory” devices which are even more hard-wired. Under unusual environmental incentives, agents are ready to re-evaluate their routines. Likewise, under more-than-unusual environmental incentives, genes can be re-assessed. This entails that phenotypic plasticity exhibited is not merely “allowed” by the genes. Plasticity should rather be the starting point of analysis—used to explain how behavior can become ossified into routines and, in turn, hardened into instincts.
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