Lassie Shrugged:
The Premise and Importance of Considering Non-Human Entrepreneurial Action

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HIGHLIGHTS

- Study engages the premise that the sociobiological roots of entrepreneurial behaviors are not unique to humans.
- Scholarly interest in the biological and neurological microfoundations of entrepreneurial action is steadily increasing.
- Extensive evidence demonstrates that non-humans engage in novel action that generates reproducible benefits.
- Provides a self-reflective framework for deeper consideration of the sociobiological origins of entrepreneurial behaviors.
- Challenges existing assumptions embedded in dominant theories and opens promising, lines of inquiry for future research.

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ABSTRACT

While management and entrepreneurship scholars have displayed comfort in and receptivity towards anthropomorphizing organizations, technologies, and even algorithms, our field has not yet grappled with a mountain of empirical evidence gathered over decades of research in the natural sciences that non-humans may behave entrepreneurially. For reflection and valuable perspective, our study relaxes the central assumption that entrepreneurial behaviors are the exclusive domain of human beings. Doing so invites fresh insights concerning the transversal nature of entrepreneurial action, the biological origins of innovation and entrepreneurship, the categorical assumptions demarcating the field of entrepreneurship, and the persistent emphases on intendedly rational conceptions of entrepreneurial action. The inspiration for our study involves "moving back from the species," as E.O. Wilson advised. Through this "more distanced view" and by focusing on the reproducible benefits of entrepreneurship rather than narrower, human-centric conceptions of firm formation and profit generation, we find that the consideration of non-human behaviors contributes to the evolving definitions and future study of entrepreneurial action.

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"The social sciences and humanities have been blinkered by a steadfastly non-dimensional and non-theoretical view of (humankind). They focus on one point, the human species, without reference to the space of all possible species' natures in which it is embedded… (remaining unaware) of the significance of biological processes underlying human behavior… That perspective can be gained by moving back from the species, step by step, and taking a deliberately more distanced view." – E.O. Wilson *(Tanner Lecture on Human Values,* 1979*).*

"That which you do not know, is not a moral charge against you; but that which you refuse to know, is an account of infamy growing in your soul." – Ayn Rand (*Atlas Shrugged,* 1957)

1. Introduction

The ability to "exchange one thing for another," wrote Adam Smith in *Wealth of Nations*, (1776) "is common to all (humans), and to be found in no other race of animals." In the two and half centuries since Smith penned these words, more than a dozen fields of scientific inquiry, including zoology, primatology, and ethology, have shown that Smith's assertion is simply wrong. Through painstaking research conducted over many decades, extensive evidence now exists demonstrating that non-humans engage in market-making activity by creating and exchanging value (e.g. Bshary & Grutter, 2005; de Waal, 1997; Noë & Hammerstein 1995). These findings

support E.O. Wilson's early view that the most compelling and enduring theories about the emergence of complex social systems are rooted in sociobiological linkages shared by humans and non-humans (Wilson, 1975: 201). Although critics raise concerns about the dangers of material reductionism in sociobiology, for Wilson, the expanded, multi-species form of inquiry functions as a comparative social theory (Wilson, 1979), enabling scientific researchers to identify the factors contributing to the emergence of social organization across different species (de Waal & Tyack, 2009). This, in turn, shifts the emphasis to explanatory frameworks propounding biosocial commonalities between *homo sapiens* and other animals (De Waal, 2016; De Waal & Tyack, 2009). The question is: *Do non-humans behave entrepreneurially?* And, if so, *so what?*

The answer to these questions resides at the confluence of ethology, genetics, sociobiology, and the growing interest among scholars regarding the biological drivers of creativity, innovation, and entrepreneurship. If biological factors play an active role in shaping social behaviors like entrepreneurship, then the prominence and strength of biosocial linkages point towards potential value in relaxing the human-centric assumption of entrepreneurial behaviors. Of course, doing so runs the risk of inciting alacrity, incredulity, or both, especially given the extent to which scholarly attention has centered on the role of rational, deliberative humans who set about servicing the creative font of entrepreneurship (McClelland, 1987; Miner, 1997).

Therefore, what benefit is there to engaging the possibility that non-humans behave entrepreneurially? If the motive is pure provocation, then the premise of non-human entrepreneurship may incite colorful debate, but few material insights. There are, however, many reasons why entrepreneurial behavior among non-humans is worth a more careful consideration by entrepreneurship scholars, each of which offers important contributions to the study and practice of entrepreneurship. In this paper, we explore three such reasons: First, the premise and importance of non-human drivers of organizational and managerial phenomena is not new. The

anthropomorphization of organizations (Shepherd & Sutcliffe, 2015), technologies, and even algorithms (Townsend & Hunt, 2019), has become a commonplace consideration, making the exclusion of non-human animal innovators increasingly conspicuous. Second, accounting for the socio-biological drivers of entrepreneurial behaviors expands fundamental notions of *reasoned action* to build more robust and veridical theories of entrepreneurial action (Hunt & Lerner, 2018; Joas, 1996). Third, extending and enhancing the combined work of ethology, genetics, and sociobiology enriches entrepreneurship theory through exploration of sociobiological drivers of creativity, innovation, and entrepreneurship. Fourth, consideration of non-human entrepreneurial behaviors materially informs debates regarding the extent to which reasoned intentionality and *a priori*, judgement-based decision-logics may (e.g., Foss & Klein, 2012) or may not (e.g., Lerner, Hunt & Dimov 2018; Wiklund et al. 2018) be a necessary precondition to entrepreneurial outcomes. Cognizant of this multi-disciplinary confluence – and sensing its importance to the field of entrepreneurship -- the central purpose of this paper is to engage the logical possibility that the sociobiological roots of entrepreneurial behaviors are not unique to humans.

2. Sociobiology and entrepreneurial behaviors

The Greek philosopher, Protagoras, is famous for declaring, "Man (sic) is the measure of all things." Yet, genetically speaking, the premise has always been suspect. Despite all the attention focusing on the differences between *homo sapiens* and other life forms, chemically, humans are identical to other species in terms of the genetic building blocks, consisting of Adenine (A), Guanine (G), Cytosine (C) and Thymine (T), and the vast preponderance of DNA (Snustad, 2011). Extensive evidence now supports the notion that the behaviors of different species (Grandin & Neesing, 2013) are influenced by specific configurations of DNA encoded within and among various species (Plomin, et al., 2008). It is possible, of course, that it is precisely these small differences in the genetic code that are primarily responsible for the talents and achievements of

homo sapiens. Yet, researchers studying primates, other mammals, birds, and even cephalopods, have noted the prevalence of "remarkable behaviors" and "complex intelligences" (De Waal, 2016; Rhodes, 2018). Keefner (2017:23) summed up the disconnect between perception and reality:

> "There is a common belief, referred to as "human uniqueness," that humans are different in kind rather than degree from other animals… Despite our continuous discoveries of evidence in animals for the very capacities that we once thought separated us, the perceived divide between human and animal minds remains exaggerated."

In fact, neurophysiology has isolated the brain activity associated with creativity, innovation, and other cognitive patterns that lead to entrepreneurial actions, and has found many facets that are not unique to humans, especially among vertebrates (Premack, 2007). Furthermore, Nofal and colleagues (2018: 23) have noted that "researchers found that genetic factors account for 82% of the covariance between creativity and the tendency toward entrepreneurship (Shane & Nicolaou, 2015)." The covariance explained by genetics as it relates to other phenotypes (e.g. sensation seeking) and the probability of engaging in entrepreneurship also shows highly significant connections (e.g. 46% in the case of sensation-seeking -- Nicolaou, et al., 2008). Thus, the biological drivers of entrepreneurial behaviors have become non-ignorable, even while they are not completely understood. Given (i.) the extent to which genetics underlies behavior, (ii.) the impossibility of reverse causality, (iii.) the non-human origins of human DNA, and (iv.) the extent to which humans are genetically far more similar to non-humans than dissimilar (Plomin, et al., 2008), how can the biological underpinnings of entrepreneurial behavior be exclusive to humans?

2.1 Entrepreneurial actions and behaviors

In recent decades, the entrepreneurship literature has moved beyond exclusively considering (and defining) entrepreneurship and entrepreneurial action as the mere launch of new for-profit business ventures. It is now generally accepted that not only can entrepreneurial action occur within existing firms, but that venturing might be social, cultural, institutional, or

environmental. Thus, in order to address the question of whether non-human actors behave entrepreneurially, it is necessary to interpret nascent-stage actions in terms that are relevant to accepted meanings of "entrepreneurial" and "action". Regarding action**,** contemporary discourse in entrepreneurship theory builds on a robust, broad, and deep literature on action theory that spans two millennia, extending from classical antiquity through the European Enlightenment to our late modern age (Coleman, 1986; 1990; Parsons, 1968; Weber, 1947). In Aristotle's view, "All human actions have one or more of these seven causes: chance, nature, compulsions, habit, reason, passion and desire," though subsequent scholarship, including the study of entrepreneurship, has not directed attention to each of the seven in equitable fashion (Hunt & Lerner, 2018). Instead, action theorists have largely characterized the nature and role of human action by focusing on the intentional, rational, and individualistic nature of human action (Coleman, 1986; 1990; Collins, 1988; Hedstrom & Swedberg, 1998; Kim et al., 2016). While there is clear substance to these more mindful motivators, more recently scholars have taken steps to expand the boundaries of motivations and actions to include less-deliberative logics as well (Lerner, Hunt & Dimov, 2018; van Gelderen et al., 2019). In entrepreneurship scholarship, this has been made manifest through inquires related to drivers such as passion (Cardon et al., 2009), affect (Baron, 2008), emotions (Cardon, et al., 2012), and quite recently, impulsivity (e.g. Hunt & Lerner, 2018; Wiklund, 2019). In positing a wide spectrum approach to the roots of entrepreneurial action, neither agency, nor the role of rational, deliberative judgments are negated, but the bases of the precipitating behaviors leading to entrepreneurial action now include a more complete profile of human motivations.

As for the other key term, "entrepreneurial," foundational work in defining the term is far from unanimous, but the gravitational force of Shane and Venkataraman's (2000: 218) conception

of entrepreneurship as the study of "how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited," is integrative and measurable. Although the "goods and services" stipulation fails to fully subsume important facets of social, environmental, institutional, and cultural entrepreneurship, the emphasis on discovery (or "creation," per Alvarez & Barney, 2007) is core to entrepreneurship theory, as successive generations of entrepreneurship scholars have contended that without action there is no entrepreneurship (Kirzner 1979; McMullen & Shepherd 2006; Schumpeter 1934; Shepherd, 2015). Across its many expressive forms, entrepreneurship represents a fundamental act of social agency. Through it, actors attempt to shape the environments in which they are embedded (Battilana, Leca, & Boxenbaum, 2009; Jack & Anderson, 2002). In this sense, Davidsson's portrayal of entrepreneurship as "micro-level action that can have hugely important macro-level implications" (2004: 6) is both intriguing and informative. Fundamentally, this conception has notable parallels among non-humans (e.g. Bshary & Grutter, 2005; de Waal, 1997; Noë & Hammerstein 1995); but given physiological differences and the importance of socio-cultural contexts, the specific ways in which non-humans may act entrepreneurially requires additional thought. For example, chimpanzee societies consist of communities commonly ranging in size from ten to twenty individuals (de Waal, 2016), so the immediate influence of micro-level action on macro-level implications is likely to be temporally and spatially quite different from human societies.

Given these contextual differences, wouldn't it be easier to simply *not* refer to non-human behaviors as being entrepreneurial, but instead categorize them as species-specific actions? In order to meaningfully assess the nature and substance of *entrepreneurial action* among non-humans, it is necessary to separate it from classical conceptions of *entrepreneurship*, which are unavoidably human-centric since all scholarly instances of entrepreneurship are drawn from

human societies. In actuality, human-centric measures of firm foundings, market launches, exit strategies, financial performance, and self-employment tell us much more about the structure and categories of human society than they do about the substance of *entrepreneurial behaviors*. Thus, in a manner that is amenable to all mechanisms and forms of entrepreneurial action we define entrepreneurial behavior as: *novel action to generate reproducible benefits*. Conceptualized in this fashion, it is relevant to step back and consider the behavioral cascade leading up to such action.

2.2 The cascade from emitted behaviors to entrepreneurial action

Critical to a conceptualization of any entrepreneurial action – human or non-human – is an understanding of the emergent nature of the phenomenon (McMullen & Dimov, 2013). Entrepreneurial outcomes by *any* living organism stem from initiating actions emanating from a wide variety biological, social, environmental, and individual motivations (Lerner, Hunt & Dimov, 2018). A stylized depiction of this emergent process is presented in Figure 1.

INSERT FIGURE 1 ABOUT HERE

In a fashion analogous to Mintzberg's theory of planned and emergent strategy (1979), contemporary research has coalesced around a collective understanding that entrepreneurial action has varied origins, including both less-deliberative, largely impulsive actions as well as manifestly intentional, well-deliberated plans. These can be grouped as System 1 and System 2 logics, respectively, in line with the cognitive processing approaches developed by Stanovich and West (2000) and Kahneman (2011). Often, emitted behaviors will be extinguished without consequence – as indicated in Figure 1 -- such that "nothing" comes of them (Skinner 1953). Of the behaviors that become creativity, some number will become innovations (Saleh & Hunt, 2020), which consist of the "qualitatively novel phenotypes" that have a significant impact on the surrounding community, its ecosystem, and the diversification of all subsequent lineages (Hochberg, et al., 2017). Examined in this cascading fashion, there is no obvious reason to believe that non-humans

are *de facto* excluded from instigating behavioral modalities that eventually result in emitted behaviors that evolve into an innovative basis for value creation and value capture. It has been amply demonstrated by ethologists that non-humans are creative (Rhodes, 2018) and innovative (de Waal, 2016) within the context of small, but highly functional societies replete with rudimentary economies (de Waal, 1997; Hammerstein & Noë, 2016). Given these widespread behaviors, given the importance of genetics to entrepreneurial action (Nicolaou, et al. 2008), and given the genetic overlap between humans and non-humans (Figure 1), why would it be presumed that entrepreneurial action is exclusive to humans?

While there may certainly be important differences among the species-specific, pre-creative inputs, both planned and emergent dimensions play an indispensable role, but in differentiable proportions among humans and non-humans. Non-humans, to varying degrees, are more likely to rely upon instinctual, System 1, biology-based inputs, but the precise ratio is ultimately a matter of degree, not kind (Darwin, 1872; Keefner, 2017; Tolman, 1951). In similar fashion, the instinctual drivers for human entrepreneurial action may be less pronounced than cephalopods, cleaner fish, or chimpanzees, but these are still causally functional. Entrepreneurship scholarship that valorizes the actions of single actors – emphasizing leap-frog technologies and the heavily curated "wow-factor" of celebrity entrepreneurs – may significantly overstate the role of rational judgements and deliberative intentionality (Lerner, Hunt & Verheul, 2018; Van Lent, Hunt & Lerner, 2020), to the exclusion of novelty, innovativeness, imagination, recombinatorial actions, and transformational leaps among more commonplace businesses by entrepreneurs operating outside the public eye (Aldrich & Martinez, 2001; Aldrich & Ruef, 2018). Similarly, the widespread use of and undue reliance upon artifact-based, human-centric operationalizations of entrepreneurial action -- such as self-employment and firm formation -- have a stultifying effect

on research attempting to identify, describe, and predict the socio-biological underpinnings of entrepreneurial behavior among non-humans. Given that the adaptive benefits of creativity and innovation are essentially settled science (Benjamin, et al., 2012; de Waal, 2016; Koellinger, et al. 2010; Sapolsky, 2010), non-human actions to create and capture reproducible value through novel action may involve entrepreneurial behaviors even if there is no analog to self-employment or firm formation in non-human contexts. This highlights the need to consider biological drivers.

2.3 Biological approaches in entrepreneurship research

Research exploring the biological and neurological foundations of entrepreneurial action is a growing field within the domain of entrepreneurship scholarship (De Holan, 2014; Halko, Lahti, Hytönen & Jääskeläinen, 2017; Lahti, et al., 2018; Nicolaou & Shane, 2009; 2014; Koellinger et al., 2010; Smith, 2010; van der Loos et al., 2011). Through varied means and methodologies, this stream of research is in the early stages of exploring how biological (e.g., Johnson et al., 2018; Lerner et al., 2021), neurological (e.g., Krueger & Day, 2010; Ortiz-Terán et al., 2013), psychophysiological (e.g., Lerner, Hatak, & Rauch, 2018) and genetic factors (e.g., Koellinger *et al*., 2010) shape different forms of entrepreneurial action. To date, several interesting insights have emerged through this research regarding the biological foundations of entrepreneurial action (Nicolaou & Shane, 2014). For example, the occupational choices of separated twins disentangles the influences exerted by genetic and environmental factors on the self-employment decisions (Nicolaou et al., 2008). Genome-wide studies of the genetic precursors to entrepreneurial action are careful to note, however, that no single "entrepreneurial gene" is responsible for an individual's occupational choices (van der Loos et al., 2011). Rather, the influence of biological factors on entrepreneurial action is mediated through a longer chain of complex forces that shape the predisposition towards various forms of entrepreneurial action in complex ways (Shane & Nicolaou, 2015). Across this emergent chain, the effects of genetic

variation are mediated through the physiological characteristics of individual actors, which then shape the psychological factors that are the most proximal influences on individual behaviors (Shane & Nicolaou, 2015). Figure 2 below illustrates the emergent, causal structure of the biological approaches to entrepreneurial action.

INSERT FIGURE 2 ABOUT HERE

2.4 Sociobiological approaches to research

Sociobiological approaches to behavior adopt a similar perspective on the causal chain linking genetic variation to the emergence of individual-level social behaviors, but extend the psychological model to consider how these behaviors aggregate into complex social arrangements and social structures (Parrish & Edelstein-Keshet, 1999). Much of the foundational theoretical work in sociobiology originated in the 1960s through the work of E.O. Wilson and others to explore the evolutionary role of social behaviors in shaping multilevel selection processes in biological systems (Wilson & Wilson, 2007). In much of this work, social behaviors are defined broadly as the actions that "influence the fitness of other individuals in addition to the actor" (Wilson & Wilson, 2007: 329). When the instigating action is novel and the benefits are reproducible, then the actor -- human or non-human -- has engaged entrepreneurial behavior.

In this regard, sociobiologists have observed the beneficial effects of novel social behaviors on multilevel evolutionary processes in a variety of environments and species (de Waal, 2016). While these behaviors are rooted in the underlying distribution of genetic factors encoded within each species, over time, these differences yield complex, observable variation in the sociality of species that scholars can utilize to identify key mechanisms underpinning the patterns of social relations and coordination across different species (Wilson, 1975). Scholars outside of the natural sciences have applied these key insights to address problems within their respective research domains. This includes psychology, where the study of non-humans is so fundamental as to often

be a required, full-semester course for undergraduate majors; often in courses cross-listed with zoology and sometimes even economics. Becker (1976) famously advocated blending sociobiological and economic perspectives in order to build a more robust theory of value preferences and altruism. Hirshleifer (1978: 239) referred to sociobiology as the study of the "natural economy," suggesting that a shared focus regarding "scarcity, competition, equilibrium, and specialization play similar roles in biological and economic systems." While most economists have stopped short of exploring the underlying sources of genetic variation in shaping economic choices, they acknowledge the importance of these influences and emphasize how "cultural tracking of environmental change is a group-behavior form of adaptation, which interacts in a variety of ways with genetic and population responses" (Hirshleifer, 1977; 8).

Well-cited studies support the application of consumer demand theory to non-human species (Kagel, 1975), the examination of service economies among chimpanzees (de Waal 1997), the manner in which reef fish select and reward service-providing cleaner fish (Bshary & Schäffer 2002), the role of infants as a commodity in a baboon market (Henzi & Barrett 2002), and the promulgation of well-defined, socially embedded cooperation among non-humans (Walton 1980). Thus, there is evidence of social arrangements both within and across species, suggesting that the span of intra- and inter-species welfare and care varies by species and context (Bshary & Grutter, 2005; de Waal, 2010; Hunt 2017), just as it varies among humans.

Furthermore, an abundance of empirical research confirms the prevalence of innovative behaviors among varied species, reflected in the use of novel and adaptive behaviors in response to environmental dynamism and change (Laland & Reader, 1999). These behaviors are frequent enough across different species that scientists can even identify specific psychological mechanisms that *inhibit* the pursuit of new innovations and inventive behaviors, including several obstacles to

entrepreneurial action that are well-known to behavioral researchers (Brosnan & Hopper, 2014), such as: neophobia (i.e., aversion to novel objects and situations), conservatism (i.e., aversion to pursue new opportunities), conformity (i.e., preference for copying behaviors of peers), functional fixedness (i.e., aversion to exploring novel uses of familiar objects), and endowment effects (i.e., preference for objects in one's possession versus new objects). There is also ample evidence that these "inventive and innovative behaviors" can be copied and diffused through social learning mechanisms across members of the non-human species (Brosnan & Hopper, 2014; Whiten et al., 2005), and can be adapted through a continuous cycle of innovation (Hopper et al., 2007).

3. Non-Humans and entrepreneurial behaviors: Implications for entrepreneurship theory

As we have asserted from the outset, creative and innovative actions are observable in nature, many of which play a sociobiological role in helping species to navigate novel and uncertain environments, often in a fashion that creates and captures value for the innovator and others. A large body of empirical work in zoology, ecology, evolutionary biology, primatology, and ethology has demonstrated that "biological markets" are an important fixture among extraordinarily diverse species (e.g. Bshary & Grutter, 2005; Noë 2018; Noë & Hammerstein, 1995). Virtually every prominent scientific voice -- De Waal, Noë, Hammerstein, Tolman, Wilson, and others – has come to the same conclusion, namely: there is no serious argument against the notion that animals engage in economic behaviors, complex pro-social arrangements, and reciprocal servicing agreements that are as innovative as anything conceived by humans. If this is judged to not be entrepreneurial, then how shall these actions best be labeled, and how does their categorical marginalization advance entrepreneurship studies? Relatedly, in recent decades, entrepreneurship research and practice has advanced significantly by expanding its focus beyond the formation and operation of for-profit business entities to include social, institutional, and other

forms of entrepreneurship. As Shepherd (2015) observed, maturing fields face the threat of exploitation traps and incremental work crowding out novel exploration, yet entrepreneurship scholarship has benefited from *being entrepreneurial* itself and should remain so.

The premise and importance of considering non-human entrepreneurial action is the epitome of entrepreneurial scholarly pursuit, offering an exciting and provocative pathway for the deployment of entrepreneurship scholarship to something more ambitious and far-reaching than simply constituting one of many "verticals" comprising the study of management and organizations. Fundamentally, by shifting the focus of inquiry towards *entrepreneurial behaviors* and away from species-specific, dependent variable-driven conceptions of entrepreneurial action, our transversal characterization of entrepreneurship as *the novel generation of reproducible benefits* incorporates what is most interesting about human-centric inventions, markets, and profits, without limiting itself to those narrow contexts. Doing so, repositions the field as more of a "horizontal" discipline,[1] one that adds to its increasingly broad scholarly and practical impact a new dimension, specifically: helping to connect biology, sociology, neuroscience, economics, management, and other fields in imaginative and integrative ways. The vertical and horizontal facets of entrepreneurship research embody equally important, coexistent, mutually reinforcing dimensions that enable entrepreneurship scholars to enhance and extend a vertical that is preoccupied with the multi-level complexities attendant to the creation and management of human organizations, while simultaneously providing scholars with the "freedom to roam"[2] across fields that benefit from integrative, horizontal theorization and empirical inquiry.

One of the leading authorities on non-human intelligences over the past forty years, Franz de Waal (2016: viii) famously asked the question: "Are we smart enough to know how smart

[1] Great thanks to the Editor for developing and sharing insights concerning the vertical and horizontal possibilities of entrepreneurship research.
[2] Again, credit due to the Editor the apt and humorous insight.

animals are?" Throughout his life's work, E.O. Wilson asked a similar question: "are we smart enough to know how *social* animals are?" These questions are not simply rhetorical. Since humans have emerged from nature to build cities and develop technologies, it is understandable that we commit fundamental errors in categorical reasoning by ignoring the sociobiological roots of our collective achievements. As Figure 2 depicts, culture in all its forms, certainly including entrepreneurship, is rooted in most basic elements of biochemistry, matter, and behaviors motivated by both intended and unintended aims. The emergent nature of knowledge and culture is mirrored by the emergent nature of the disciplines developed to make greater sense of these elusive connections.

As an initial step towards expressing entrepreneurship's "horizontalizing" potential, we have sought to provide a provocative foray -- through the lens of entrepreneurship scholarship -- into the sociobiological unity of innovative and adaptive actions among non-humans. Just as much of the research in neuroscience, physiology, and psychology is deeply informed by similar research with other species -- and these studies do eventually filter into entrepreneurship research (e.g. Gray 1982; Carver & White 1994; Lerner, Hatak, & Rauch 2018) -- there is intrinsic value in utilizing non-human models to better understand human behaviors. As Tolman (1951) noted, "In early times, humans garnered some of their best ideas from watching animals in nature" (1951:17). Understanding the biological roots of creative and innovative entrepreneurial action will undoubtedly challenge many of our preconceptions about the uniqueness of entrepreneurial action, but careful scientific attention to the fundamental evolutionary mechanisms of adaptation and change does not mean that we cannot appreciate the emergent social genius or subjective experience of those who strive to change the world – no matter what their species.

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Figure 1: Emergence Model of Entrepreneurial Action

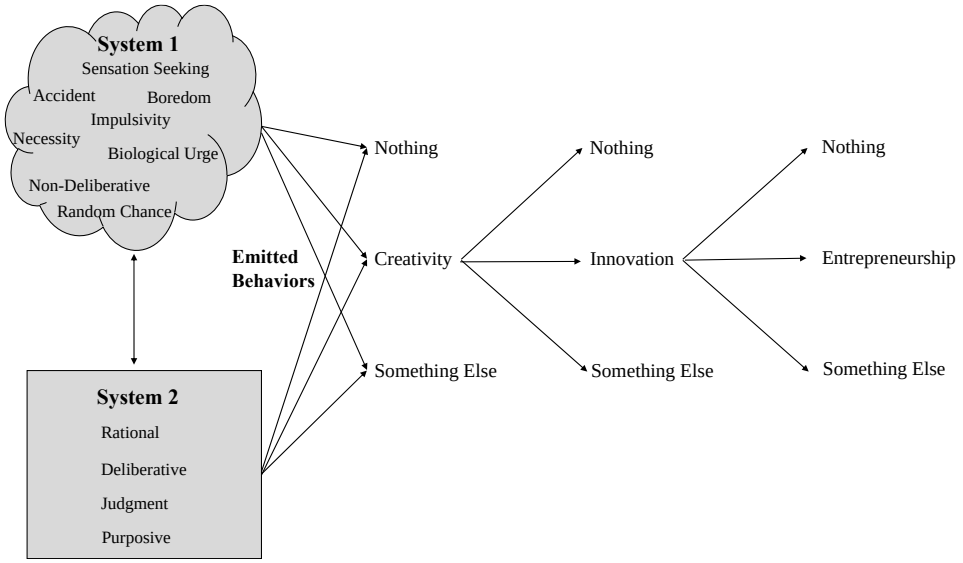

Figure 2: Emergent Causality in Biological Models of Entrepreneurial Action

(Adapted from: Shane & Nicolaou, 2015)