The Joys of Innovation

Animal Creativity and Innovation

By Allison B. Kaufman and James C. Kaufman (eds.). San Diego: Academic Press, 2015, 538 pages. ISBN: 978-0-12-800648-1. Cloth, $53; digital, $53.

Animal Creativity and Innovation complements another excellent collection, *Animal Innovation* (Reader & Laland, 2003) published a decade earlier. The editors of the present book added interest by creating dialogs, with researchers who study human creativity commenting on each chapter by researchers who report on animal creativity. The contributors span the globe, writing from places and perspectives both familiar and exotic (can you find Kalimantan on a map?). The commentators generally came away impressed with the amount of research, abundant evidence of creativity, and the parallels with some of their own research.

Creativity, like beauty and causality, lies in the eyes and ears and tongue of the beholder. Creativity is typically defined as a novel behavior or product that is functional. Some authorities also require that it be intentional. All such criteria are difficult to apply, and rule out performances that you would include. Are variations on a theme novel? What is the variation/theme ratio required to call it that? Do they have to be good variations (J. S. Bach's *Goldberg Variations*) or do parodies count (P. D. Q. Bach's *Abduction of Figaro*)? Is play functional? It functions to please the player, if that counts, and has the contingent benefit of enhancing skills of potential survival value. What is the function of music, or art, or storytelling? A novelist may find that his characters hijack his story, finishing it in ways that the author did not intend. Novelty, functionality and intentionality are matters of degree with few bright lines. To be called creative, do phenomena even need a creator? What of those "endless forms most beautiful and most wonderful [that] have been, and are being, evolved"? Transposing these questions from human animals to non-human animals stretches a broad canvas on which to puzzle them. If you don't like puzzles, don't open this book, so full of them. If you do, you will enjoy its kaleidoscopic view of the grandeur to be found in this view of life.

• The first chapter reports highlights from a life-long study of language acquisition by Grey Parrots. (The objects of the study; the author is Irene Pepperberg). Yes, they can. Just don't expect a deep conversation with them on the current status of the Novel. What do they have to say for themselves that might take you by surprise? Lots of word play from Alex, who had much tutelage. Apple he called *banerry*, a portmanteau of the names of two fruit he had learned, banana and cherry; dried banana chips are *banakers,* though he preferred simple crackers. When the experimenters needed a lunch break they said, "I'm going to go away". In the middle of tedious sessions, Alex subsequently called for a time out with "go away", and would stop working once that was announced. Alex could sum Arabic numerals, and infer their ordinal properties. His response to novel questions was sometimes ingenious. After school Alex would often, like children, babble creatively to himself, or to nearby cousins. What his cousins said about his small talk is not reported.

• Who hasn't played with his, or a friend's dog? Dogs are good at eliciting creative play behavior from humans. (Which, in my case, elicits playful remarks from my wife.) Do *we* elicit creative play behavior from dogs? Robert Mitchell provides a nice analysis of creative dyadic interactions little different than ones seen in professional-level sports, including fake outs and surprising seductions of one another to try for a ball at the very edge of possibility. Don't play this game with cats.

• "Unusual niches as well as unpredictable or seasonal resources foster a broader spectrum of foraging techniques and often promote flexibility and physical innovations" (p. 45). Variable niches drive flexible repertoires. Whereas Fido only need not bite to get fed and bed, generalists such as corvids and psittacines—crows and parrots—are less cosseted, and perform at levels similar to the great apes in a number of cognitive tasks. Alice Auersperg's chapter, like most in the book, is rife with citations to well-documented observations and experiments. The current prima donna on the innovation stage is the New Caledonian crow, who not only uses tools to solve novel problems, it makes the tools, and applies them at a level of insight that far exceeds that available to *Homo simpson*. Whereas crows' play with objects decreases after sexual maturity, many parrots cannot keep their beaks off things, inserting them, submerging them, balancing them, wrestling with them, and generally making fools of themselves. Lacking hands, they use their dexterous tongues in coordination with mandibles and feet to solve complex problems. One Goffin cockatoo pulled up a ring, unscrewed a bolt, pushed a cylinder through a ring, fit

a complicated shape through a t-bar, and pushed a lock open. Mostly just to do it. After initial acquisition he was immediately able to repeat the entire sequence. In less complicated but more diagnostic (of causal reasoning) tasks, some of these species do well, others less so. How these differential abilities relate to different niches is explored in this, and most other, chapters. In a manner not unlike dogs, corvids and psittacines elicit creative test structures from their scientists. Skinner's rat, who bragged how he had trained Fred to dispense pellets, has nothing on these birds, who get their masters to construct them miniature Legolands.

• Looking at modern world events, I sometimes want to crawl back to the sea whence I came. I'm not the first with that velleity. The great-grandma^{n} of whales and porpoises, and cetaceans in general, beat me there many millions of years ago. They Trumped me. I guess times are always tough. They brought with them, and nourished on seafood, big brains. So what in Neptune's name do they do with them in Davey Jones' locker? That is hard to say, because observation is difficult, especially under the ocean. Rather than submerging our scientific apparatus, we can emerge our subjects, up and into our labs and aquaria and sea "worlds". There we find that they like to ape us. Blow cigarette smoke at a viewing port, and a nursing dolphin may blow some mother's milk back at you. (The Surgeons General have not yet ruled …). Wipe the residue off of your side ere the aqua-vigilantes come, and the dolphin may mimic your cleaning behavior, stance and all. While smirking at you. Why should they be so…quick? Eric Patterson and Janet Mann speculate—social living, relative safety from predators, and who knows. (But who knows why *we* are so much smarter than we seem to need to be; except in the case of social polity?) With more than 500 captive cetaceans in the US alone there are many opportunities for observation (perhaps to see them asking one another "now, just what was it that we did to get life?").

As you may have observed, dolphins, like parrots, don't have hands; but they have blowholes that let them bubble, and mouths that let them squirt. Their playfulness with these actions ranks with 4-year old kids. They use water jets in tanks to launch objects to chase, either for themselves or mates, with whom they alternate at launching and catching. Fido again. Scientists can raise the stakes on play. In a classic study, Karen Pryor required a dolphin to do something different every day to get her fish (the dolphin's fish). After running through her standard repertoire, and then after several days of 'writer's block', she (Malia, the dolphin, not Karen) rose to the challenge and started doing things never seen.

The Creative Porpoise was published in a Skinnerian journal (apparently behaviorists can be as creative as their subjects. Just takes conditioning.). The dolphin's repertoire of creative or routine was brought under stimulus control; "tell us what you want" the dolphins seemed to say, "sedulous or goof off? If there might be a fish in this for us, then you got it!"… "Then again, we might just play with you".

In the sea, we see them at their behest—whether mimicking an awkward human snorkeling and blowing bubbles, or leading our whaling ships to prey, where they get the residue. Some of their whimsies become fashionable, like a killer whale swimming around with a dead salmon on its head, which spread to several pods. (Ahh haute couture! Next spring, bass couture?) Dolphins love to surf. They do it as occasion and surf arises, alongside a whale if necessary; and sometimes it is necessary to coerce the whales to surge ahead, which they have learned to do. Just *why* they love to surf is a question that you must address to Southern Californians, who have not yet mastered the art of annoying whales into getting the surf up.

Dom Massaro 12/16/2015 11:05 AM

Comment [1]: I'm puzzled by this one -
Cross-language puns stretch the observer's ear: whereas haute couture is high style, bas couture is low style. And when salmon hats go out of season, will bass ones emerge next year? Here I have added an s to bas, to possibly help the reader. (I went back and forth several times figuring how best to couch this). But if it still isn't going to work, please take it out for me.

That is play. When it comes to work, it is a dirty job, nosing around in sharp underwater environments. A few dolphins protect their delicate noses by putting gloves on them—rooting up marine sponges and putting them over their noses/beaks (they prefer the term *rostra*). This OSHA-approved safety technique is learned by 95% of the daughters, but by only half of the sons. Being a father, I immediately understand this difference.

So why are these sea-mammals so playful? The authors speculate. Safe niche that allows play, or broad niche that fosters innovation? Or is it sex, always a good default explanation--cherchez la femme cetacean--that causes dolphins, like youth everywhere, to get goofy? Don a wetsuit and dive into this fascinating chapter to see what ideas bubble up.

• Gordon Burghardt muses on "how do we determine if behavior in animals, human and nonhuman, has these qualities…creative, novel, innovative, inventive, original. … ingenious, insightful, resourceful, and artistic…and, if they do, how do they arise and come about? (p. 131)". He downplays the need for radical novelty, noting how even the most creative scientific discoveries have built on similar prior ones, and that much science is the extension into adulthood the play of the child, whose every first step and little invention is for her novel, creative and sometimes functional. (Oh, that reviewers of my manuscripts would reward me with such words!) Three types of play in animals are recognized: locomotor/rotational (break-dancing), object (sandbox), and social (playground).

Burghardt provides an operational definition, a theory (Surplus Resource Theory—essentially play happens when you have time energy and skills to goof off), and a list of the many benefits of play. The benefits include the obvious, plus some not so—exercise and vigorous play can, through the mysteries of epigenetics, reprogram our DNA with consequent health benefits. (I fear that this can go the wrong way as well, with some real possibility that I may literally devolve to a couch potato.)

Burghardt provides a useful review of some of the classic books on creativity. Each parses and elaborates the concept in different but reasonable ways. Many trip over the same wires, imho: Wanting to reserve the term for something that we admire, or that will be successful in the long run; or restricting the term to ideas, always difficult to measure in animals, both human and non (remember Nisbett and Wilson's subjects, who so readily told more than they could know? And Fido, who can tell less?). I most like the author's characterization of play as a mechanism for creating variation in repertoires that may be selected by biological and cultural forces. In fact, it enables all three elements of evolution: through novel combinations promoting variation; through trial and error permitting selection; and through rehearsal solidifying retention.

• Innovations in foraging behavior are frequent. Daniel Sol cites the compilation of Lefebvre and associates of more than 2000 innovations observed in hundreds of avian species. Sol identifies four factors necessary for these innovations: To paraphrase, they are exposure (to environments where there may be opportunities); recognition (of an opportunity); problem solving (to exploit the opportunity); and incorporation (into the repertoire of the previous 3 steps). He lists the ways in which motivation, emotion, cognition and morphology can interact with each of these processes. Each of these factors (e.g., neophilia) can evolve as an adaptation, or as an exaptation (a trait selected for their support of other functions that later become useful for this function). He then details how these traits, even when governed by independent mechanisms, may be correlated—a process such as innovation requires all of them to be successful. When they are, what results is often a "creative lifestyle"/niche. The heart of his argument is that the various factors may evolve unevenly, so that creativity can take many forms; and that in some cases, innovation may itself be an exaptation, riding on the coat tails of forces that select one or more of its component factors.

• Exposure requires locomotion, and locomotion requires a cerebellum, and creative cerebella are Laura Petrosini and coauthors' subject. Brain scans show an important role for parts of the cerebellum in novelty seeking and

observational learning. Indeed, the cerebellum has been shown to play a role in many traits associated with creativity, such as cognitive flexibility. The commentator on this chapter, Mathias Benedek, astutely noted that many studies from his and others' labs have shown activation of the cerebellum during creative idea generation, but their reports spend little or no time with the cerebellum, quickly moving to the cerebral data. Benedek suggests "this is not due to contemptuous ignorance [I love that phrase], but rather due to the lack of available cognitive models that would allow a clear-cut interpretation of the role of the cerebellum in creative thought (p. 210)". As Einstein informed Heisenberg, "It is the theory which decides what can be observed". Or as Reverend Bayes might have said to Fisher: "It is your priors which direct where your posterior will sit" [cerebellum willing].

• In the next polyauthored chapter, Kendra Knudsen and colleagues drill down from brain modules to genes. They identify three aspects of creativity: novelty generation, working/declarative memory [more ideas active to recombine], and response inhibition [wait a minute now…], and show how these relate both to creative performance and to neurohormonal and genetic underpinnings. For instance, the sense of creativity as existing "on the edge of chaos" is mapped onto the dopamine receptors of the D1 types (excitatory) and the D2 types (inhibitory), and the differences across species in the tonic and phasic differences in D1 and D2 transmission.

• Ana Navarette and Kevin Laland study non-human primate innovation. After the mandatory musings on definitions, they note that innovation is unevenly distributed even in closely related species. The Japanese macaque that learned to clean her potatoes and to separate sand from her grain by washing them in a pond, is a sister species of the Formosan rock macaque, which "has never been observed performing a novel behavior". (Remind me later to tell you about my brother-in-law Arthur). The authors cite research showing an amazing correlation between innovation rate and social transmission rate ($r^2 = 0.56$), after correcting for research effort. The correction is essential, because one ape's innovation is another's copycat. Even so, some of the direction of causation is open to question. The authors speculate about the niches that foster creative species, and interestingly about the costs of innovation—increased predation risks, consumption of hazardous foods, and opportunity costs in general. Innovation rate has also been shown to correlate with brain size (as has deception—very innovative behavior, if you take my word for it). But the best way to measure brain size becomes another disquisition. The cerebellum is not ignored, nor are

the neuroenergetic costs of a large brain. Nothing, in this detailed chapter, is ignored, including the potential utility of causal or directed graphs in inferring direction of causality in these rich correlational fields.

The commentator on this chapter, Thomas Ward, makes the obvious but essential point that the verbal ability of humans, their ability to instruct, to tell and to write stories, has a multiplier effect on innovations. None of us needs to reinvent the wheel (even though Volkswagen apparently needs to reinvent the engine). Remarkable as all the innovations we are exposed to in this book and in this chapter, they are peanuts compared to those of the Neolithic flint-knappers, whose descendants now knap flint on the moon, and whose machines do it on comets.

• Jackie Chappell and coauthors start with a scenario all too familiar to me, the kind of primate in question, but one whose thumbs don't always oppose like they should. You are working on your car and drop a small screw into the depths of the engine. What are the cognitive and behavioral processes you go through to locate and retrieve it? (Look for the answer at the end of this review). After that bracing example the chapter segues to the mandatory but no longer novel musings of how to define the subject, innovation. The authors accurately observe that "Innovation is easy to identify when you encounter it, but difficult to define precisely". Well, one knew that after the first couple chapters of this book. The observation redeems itself, however, by reminding us of the greatest obiter dicta of the US Supreme Court, Stewart Potter's "I don't know how to define pornography, but I know it when I see it". We suspect he meant "I know it when I feel moved by it". And I believe that that is also true of innovation and creativity: we know it when we feel moved by it.

The chapter continues with a review of innovation in human and non-human animals, focusing on problem solving. I was surprised to read "to date there is limited research on innovation in humans…[and that] has shown that innovation is hard and occurs infrequently" (p. 299). For years I taught a course called Effective Behavior (not a sexy title, but one that avoided the negativity of critical thinking, while emphasizing the embodiment and goal-orientation/action roles of cognition). Creative problem solving can be taught. Like many skills, it might be rare and difficult absent tuition. It is something like playing a harp: That is hard and occurs infrequently (not infrequently enough if you ask me); but, like walking and writing, innovation and harping are skills that improve with practice. Innovation may not be so obvious in our culture, because we have solved most of our quotidian problems, or hired mechanics with fully opposable thumbs to do

that for us. In *The Wealth of Nations*, Adam Smith observed that efficiency and consequently quality of life would be enhanced by division of labor; but at the same time "The man whose whole life is spent in performing a few simple operations…has no occasion to exert his understanding or to exercise his innovation [to] remove difficulties which never occur. He … generally becomes stupid and ignorant…". Smith recommended state-sponsored mass education to relieve the "torpor of the mind". That is why you and I have the jobs that we do; jobs that themselves are experiencing recent division of labor, threatening torpor of the mind, if not contemptuous ignorance, among us.

What I liked most about the chapter was the many apparatuses created by the various researchers, and the problems those set, permitting me to measure my own abilities against those of rooks and bonobos. In many cases the stumbling block for the animals was the failure of inhibitory control—the failure to avoid the apparently quickest route despite the presence of a fatal flaw along it. (What my mother often reproved as my "wishful thinking"; which I thankfully outgrew, after tenure). Another problem for kids is that they often do not recognize that it is OK to think outside the box. The authors noted the greater difficulty of everyone with ill structured problems, ones lacking all the necessary information about the start or the goal states, or the possible solution paths. This is where virtuoso creative, organization and executive skills are essential. Consider the problem of creating a small clean efficient diesel engine, but where there are no viable solution paths. If you were the president of a German motor works, how would you go about solving that problem? Is it OK to think outside the box?

• Phyllis Lee and Antonio C. de A. Moura (I want a name like that!) explore the ecological drivers of innovation. One is variability of resources; during times of plenty, no significant downside to experimentation, which then might stand you in good stead during times of scarcity. The second is the familiar mother of invention, necessity. The third is opportunity, which longer life spans afford more of. The authors test these ideas with Capuchin monkeys living in different forests, some of which use sticks to fish for termites. They found that plots lower in fruit and higher in nests were associated with more time spent fishing. Figures; but proof is good. The authors also discuss ecological issues in innovation of sexual displays, communication of emotion, and social interactions. They summarize with an innovative display of Euler circles showing how the various factors named throughout this book come together to support innovation. The commentators add an additional ecological factor that may drive creativity, that of

early stress. Given the massive flow of refugees out of the Middle East, there will soon be an unfortunate opportunity to test this hypothesis. Let us hope that they are right, providing a minor glimmer in that dark night.

• The next chapter is by a colleague whose work I have admired as some of the most innovative in the field. And, true to form, Tom Zentall starts with a counter-intuitive claim: social learning is at the heart of innovation. It is counterintuitive, because such observational learning should decrease necessity (the familiar mother). But he observes that one must really have mastered the themes before one's variations are likely to work: Chance favors the prepared. Zentall is prepared to review the definition, data, and interpretation of mechanism and ecological factors in social learning, which he takes this opportunity to do, and executes adroitly. Issues involve immediate vs. deferred imitation, social influence vs. social learning, emulation and perspective taking. Social influence includes effects on motivation, elicitation of an action pattern (contagion), and orientation (redirection of attention). Examples range from socially transmitted food preferences to socially conditioned fear responses, emulation via affordance learning, birdsong, and traditions. Generalized imitation has even been brought under stimulus control, with apes, dolphins, dogs and parrots able to mimic the actions of the trainer after the command (e.g., "Do this!"). Many considerations and experiments are involved in parsing the control of behavior into these relevant categories, reminding us again that the parents of innovation, necessity and opportunity, are nowhere more evident than in the scientific process, when played at the level reviewed in this book.

Zentall reviews various theories competing for this rich field of opportunity: Associative learning (several problems with this account); kinesthetic-visual matching (limited explanatory range); response facilitation (but how to make that work is nonobvious); and the mirror neuron hypothesis (despite some problems, and work to be done, his favorite). Social learning is central to the recent evolutionary success of our species, and needs continued research such as this. The more recent proliferation of "copy-cat" actions promulgated over social media has become a disruptor of that success, and of its stability. Understanding these processes is a national priority.

• Robert Epstein opens by rightly noting that the label *creative* is typically applied when a production is novel and pleases (or at least surprises) the labeler. In one of his earliest experiments in this field he showed how, given the right environment, pigeons could solve the same classic box-and-banana problem that Köhler studied with chimps, and which came to be called "insightful". He notes

that people have been observing novel problem-solving in animals all along, recounting an arms race between him and his dog centering on what should have been an impregnable gate. (I have the same story to tell about my dog Lucy, but replications, being unnovel, are uneasy to publish). Epstein reminds us of some of the famous demonstrations of creativity, such as those of the New Caledonian crows (their act is starting to get old; time for new writers). He mentions the debate as to whether creativity in animals demonstrates clear signs of human-like cognitive activity. Epstein argues, correctly imo, that it is a pointless debate. (Indeed, I wonder how often creativity in humans demonstrates human-like cognitive activity).

More than other contributors, Epstein discusses the creative niche of art: "esthetic (Michelangelo), economic [Apple iProducts], or even just bizarre (Lady Gaga)". If we allow these as creative, why not the art of elephants, gorillas, orangutans, chimpanzees and bowerbirds, all of which may pass the Turing test of artfulness, and may be indistinguishable from some human art? Epstein then regenerates his Generativity theory: "(i) new behavior emerges as previously established repertoires of behavior become interconnected over time, and (ii) the interconnection process is both orderly and predictable" (p. 381). Makes sense. As frosting he demonstrated the process by re-expressing it in terms of the underlying conditioning mechanisms, writing it in equations, simulating it in a computer program, and making successful predictions of behavior. This regeneration is both novel, and surprising *and* pleasing. As a behaviorist, he calls for more extensive recordings of creative and problem-solving performance, so that the component acts of which innovation is composed may be studied. This would provide a much stronger basis on which to build theories than many extant reports do. I hope he pursues this experimental analysis of creative behavior, as it is orthogonal to most other efforts, and thus provides the possibility of opening a new field of opportunity, both for analysis and useful synthesis.

• Joseph Call (his name, not an injunction) sets the problem he will address in his opening lookup: "Dictionary.com defines innovation as the 'introduction of new things or methods' and it lists 'tradition' as one of its antonyms." But we know that there is a strong correlation between social learning and tradition—a positive correlation. His goal is to address the paradox—a task also assayed by Zentall—focusing the question on the performance of apes. He does so in the context of laboratory and field, and the stories again make fascinating reading. (W. C. Fields wittingly banned dogs and children from upstaging him; Mae West he didn't mind). Questions such as: the relative

durability of social learning and personal experimental learning, set against one another; Functional fixity; Learning sets; Personality; Idiosyncratic componential repertoires; Social conformity. Many data, mostly from the laboratory, are arrayed to throw light on the complementarity of social learning and innovation. The commentator, Niu, draws parallels with human cultures, and concludes: "Preserving tradition and striving for innovation are both important adaptive mechanisms that are not necessarily on opposite ends of a spectrum; rather, they can work hand in hand in facilitating cultural progress. The findings from animal research seem to echo what we have learned from research with human beings, and eventually help us better understand the progress of cultural evolution" (p. 418).

• Anne Russon and co-authors provide the most primary data, and the most pleasing pictures. It is about that old man of the forest, so difficult to study, living in a canopy above swamps. The utility of tools way up there is moot (think of the screw dropped, not above the motor, but above the morass, and imagine what was said). But in this book it would be unpatriotic not to creatively expand the implicit definition of tools from "something you hold in your hand or beak", to anything you use to achieve an end. (I approve; I even know of some people who use other people as tools; but most often by holding them in the palm of their hands.) On the ground orangutans have been recorded using three dozen tools, only slightly fewer than chimpanzees. (I am close). But up there in the canopy, orangutans use the trees themselves to achieve many ends. Getting from one treetop to another, especially with their big bellies and the passage involving thinner and thinner branches, constitutes the major regular problem that they face. When they do descend, they need to cross water barriers, another big problem. The authors' thoroughly operationalized methods section is relieved by their descriptive labels (in making seats for eating, there is the *bent branch*, *cherry picker*, and the *X-chair*. The last of which my wife has recently prohibited me from using. But maybe I am telling you more than you need to know). Amongst those for locomotion are various bridges constructed on the spot, oscillating the tree to get it closer to the target tree, pole vaulting, liana (*tarzan*) swing, catapulting with lianas, and bungee jumping. (Oh, those old men are kids at heart, imho; 'gives hope.) The bungee jump, in case you're wondering, was to get at grass on a riverside where wild pigs and cobras hung out. Boing, grab grass and your out; boing … . Life is hard. But can be fun. Then there's *zipper* \ deleted by editor, DM, to maintain PG status\.

These were hard-earned data, of which I have skimmed only the florid parts. The chapter greatly increased my respect for the orangutans, whom I had erstwhile imagined to be the least creative of the great apes. It is especially disheartening to know how much of their territory is being devastated for palm plantations. These are used to make palm oil, found in many foods. Even girl-scout cookies contain them. Do our cousins a favor and don't buy anything containing palm oil. Not even from a girl scout; but use the opportunity to educate. (Palm-free foraging will require some creative, but very worthwhile, super-market problem solving.)

• If any of this bugs you, wait till the chapter by Emilie Snell-Rood and colleagues, who analyse innovation in bugs (well, insects in general). Many insects can learn, and where there is learning, and social learning (lots of that in the eusocial species!) there will be innovation. The examples are less exciting than in the preceding chapters, but real. But they raise another issue; we know that most definitions start out anthropocentric. Sometimes they achieve a larger context. If the picture you just bought for $100 and you love, turns out to be made by an elephant--does it cease to be art? If a creative sexual display (you know) turns out to be genetically predisposed, does that make it less an innovative solution to a problem? Maybe. Maybe not. (If you know of a display that I don't, please tell me. For scientific reasons.)

Perhaps we should include Mother Nature and Father Darwin as creative agents. Let me tell you about an experiment that I did that involved 10,000 subjects. (I was trained in a Skinnerian *n*-of-1 tradition, so had to get out of a box.) (Actually, and in the spirit of frank disclosure, I didn't do it, a talented grad student Robert Johnson and his ingenious mentor did it; I was an exaptation. If you remember what that means). (Yeah I know; this review is getting to be a tangent all about me. But why write a review if not to opinionate?). We studied ants with different foraging patterns that exposed them to more or less environmental diversity, and posited that the ones with a more random foraging pattern would learn and forget new seeds faster than the ones with a more germanic approach. They did. But what surprised us is that the forgetting curves of the colonies for the new seed types (Kentucky Blue Grass; one of the best uses for it) had a much longer half-life than the full life of all of the foragers. The nest remembered what its inhabitants took to the grave. (Hear dramatic old-time mystery radio show music, svp). Turns out, the nest kept a library of recent seed types. Their granary was processed by young ones, who would be the next foragers. As it depleted, so did memory, unless it was refreshed. It told them

what to look for when they went out. Now, is that or is that not a creative solution of ‘what's for dinner, honey’? But it was accomplished not by individuals, but by communities; and not by thinking, but by evolving. I think. In our democracy we all can vote, and I vote for expanding our definition of what counts for innovation, in space, time, and community; slow (evolutionary) problem solving should count as much as insight. Your vote…

• Karen Pryor concludes the substantive chapters with her observations on the creative cetaceans that she has trained. “Trained creativity” may seem oxymoronic. Most training has a well-defined terminal performance to which the organism is led by successive approximations, or by conditioning and then combining componential skills. Pryor, however, was able to create creative behavior by engaging the animals and then ceasing to reward until novel behaviors were emitted. She and Gary Wilkes also introduced clicker training to shape specific responses. Once the animal was used to the clicker as a conditioned reinforcer, many novel responses could be quickly reinforced with it. She reports how the technique was adapted by many animal keepers to enrich the lives of their captives, and she links to videos of the process. Like a good trainer of trainers, she provides bulleted lists of precursor skills for the learner and for the teacher. Pryor concludes with observations of creative tricks that schools of wild dolphins use to evade capture in tuna nets.

Like, I suspect, many potential readers of this excellent book, I opened it with some skepticism. I close it with admiration. Admiration for the many serious scientists who have given their lives in creative, critical analyses and experiments, to understand better the creative aspects of life around us. It is egocentric to think that we are the only creative problem solvers in our world. Or the only artists. After all, beauty itself was created long before us, when sexual selection arose to equal natural selection in its power. Somewhere, someone may be looking at us through a one-way mirror, setting problems to test our innovative abilities; life is an experiment, we its subjects. We are not the first to rise to this challenge with innovation, ingenuity and creativity. David Cropley’s last words in his commentary on the orangutans serve as the last words of this review: creativity is not monkey business; it is our business.

Peter R. Killeen
Arizona State University
killeen@asu.edu

The answer