“Ideas are like species: they must evolve.” This claim forms the conceptual core of an engaging book by Jonnie Hughes (2011), *On the Origin of Tepees*. Hughes asks: If evolution by natural selection explains the origin of the human species, then does selection by consequences also explain the origin of what we humans make and do? This question prompts consideration of three important analogies: between natural selection and artificial selection, between the law of natural selection and the law of effect, and between biological evolution and cultural evolution. These analogies in turn stimulate examination of the notions of purpose, design, and agency. Finally, discussion moves to the selectionism of Darwin and Skinner; although still controversial, this view remains the best way for natural science to understand the origins of adaptive behavior.

*Key words*: biological evolution, cultural evolution, natural selection, artificial selection, law of effect, intelligent design, invention

*On the Origin of Tepees* is an utterly unconventional, but nevertheless extremely interesting book. With healthy helpings of the ideas of Charles Darwin, Richard Dawkins, and Daniel Dennett, British author Jonnie Hughes concocts an entertaining and provocative cocktail which addresses key issues in the evolution and development of behavior. The book is written in playful prose, but it packs powerful theoretical punches.

The setting for Hughes’ engaging journalistic endeavor is a rambling road trip through the Upper Great Plains of North America in a quest to reconstruct the evolution of tepees (yes, it rhymes with *species*). At the heart of Hughes’ project is a core conjecture: “Ideas are like species: they must evolve” (p. 134). Of course, most of us would deem tepees to be things, not ideas, and things that are the products of human behavior. Yet, it turns out that tepees were fabricated over thousands of years and across vast expanses of territory, with a variety of materials, in diverse and oftentimes distinctive ways, by many different indigenous tribes. Such fabrication was accomplished without written instructions or detailed drawings, but surely with oral traditions and imitation playing key parts in the process. Hughes wonders how this remarkable feat of apparent design could have arisen and changed without some “idea” lying behind this structural icon of our continent’s Great Plains dwellers.

Hughes’ geographical journey to chronicle tepee evolution proves not to be a single-minded affair: it prompts him to raise questions along an even broader and more profound intellectual journey. How did the wheel evolve and why might its evolution have been so slow? What accounts for the various different roofs of barns that dot the Midwest? How did humans come to breed dogs and why did we produce so many different breeds? How did the cowboy hat come to have its unique shape? What explains the winding trails that the pioneers blazed across the Midwest? Are similar instances of cultural evolution happening right now? Is cultural evolution mindful of its consequences or is it mindlessly shaped by its consequences? These questions and many more make Hughes’ book particularly pertinent to students of behavior.

Hughes considers cultural evolution to be analogous to biological evolution. Yet, his focus on the *products* of cultural evolution—tepees, wheels, barns, hats, and dogs—comes at the expense of the role of individual human *behavior* in making those cultural artifacts. Here is where most behavioral psychologists, particularly B. F. Skinner (1981), would likely direct their analytical and interpretive ener-
gies. I will do just that later in my review. But, before delving into that scholarly domain, let me first take a quick tour through Hughes’ book and then take a brief detour to the thoroughbred racetrack to highlight a realm to which I believe Hughes has given insufficient attention: namely, the origins of human behavioral innovation.

THE ANALOGY BETWEEN BIOLOGICAL AND CULTURAL EVOLUTION: ARE IDEAS LIKE SPECIES?

Despite the title of his book, Hughes has much bolder ambitions than to reconstruct the origin of tepees, a daunting task in and of itself. He wants to place cultural evolution into a biological context and to strictly apply Darwinian principles to the ever-evolving world of human ideas and inventions. Insight into Hughes’ evolutionary notions can be gleaned by considering the key concepts in his worldview: culture, selection, design, ideas, and inventions.

Culture

Hughes proposes that the human species has evolved an amazing “conjuring trick”: we can pass along the solutions to important problems of survival through a kind of repository or collective memory that we call culture. This conjuring trick not only provides the social group with effective solutions to pressing problems, but it saves countless individuals from attempting innumerable “solutions” that will inevitably prove to be ineffective.

Hughes believes that cultural evolution works in the same way as does biological evolution—in a Darwinian fashion. Culture can be seen to represent: “A brand-new mechanism by which information could be handed from one individual to another without genes” (pp. 238–239). At this point in time, cultural evolution has decidedly outpaced biological evolution, having done so largely without intention or design. “These days the

only parts of us that are engaged in a kind of evolution are the changing thoughts that fill our minds. We have (accidently) swapped one type of evolution for another: biological for cultural” (p. 33).

Selection

Darwinian evolution entails the elimination of some and the preservation of other biological variants. Here, Hughes spots a prime interpretive problem: “To many, the word selection implies that there must be some kind of intelligence or mind at work behind the action, since selections are, by definition, intentional conscious acts. That, of course, was not Darwin’s idea. Selection also suggests that nature is picking ‘the best,’ when in fact it does this only by default” (p. 83). Controversially, Hughes suggests that the same brand of mechanical or mindless selection may be involved in cultural evolution.2

Artificial Selection

Darwin made extensive explanatory use of the selective breeding of plants and animals by humans in developing his theory of natural selection; indeed, appreciating the parallel between artificial selection and natural selection was a critical step in the evolution of Darwin’s own evolutionary theorizing. Hughes claims that: “To Darwin, the activity of ‘artificial selection’ was an exact parallel of the work that nature was engaged in out there in the wilds. Indeed, the only significant difference is the speed at which artificial selection can work” (p. 83). Hughes further claims that: “If a ‘choosing mind’ is selecting from a range of varieties with inheritable traits [as in the case of artificial selection], then all it’s really doing is taking the place of nature in the equation” (p. 84).

Furthermore, the most famous illustration of selective breeding—humans’ production of pedigree dogs like Scotties—may not have begun as the methodical enterprise that most take it to be today. Hughes conceptualizes the origins of the dog along a “mindlessness-to-mindfulness” spectrum (p. 86), which began

1 Hughes does not pay a great deal of attention to the matter of variability. However, he does suggest that biological variants and cultural variants each arise from “a never-to-be-repeated interplay between a competing community of instructions, the peculiarities of the local environment, and a pinch of good old-fashioned randomness” (p. 58).

2 Simon’s interesting speculation is worth repeating here: “human problem solving, from the most blundering to the most insightful, involves nothing more than varying mixtures of trial and error and selectivity” (1969, p. 97).
with wolves, moved to domestic dogs, moved next to breeds, and then to pedigrees. Human intervention advanced the evolutionary process from the second to the fourth step and involved increasingly “mindful selection.” I more fully discuss Darwin’s own thoughts about mindfulness and artificial selection later in this review.

Design

Perhaps the most dramatic and controversial points that Hughes makes about cultural evolution involve the notions of design and ideas. Let’s put aside the tepee for the moment and consider another human invention: the cowboy hat.

Of course, we are all familiar with this distinctive item of Western headwear and its most iconic instantiation—the “Ten Gallon” Stetson. But, who designed it? Hughes’ answer: no one person designed the cowboy hat. “The communal nature of selection renders any minds that [were] (varyingly) involved in the evolution of the cowboy hat null and void” (p. 95). Most emphatically, Hughes insists that cowboys were not the architects of their own hats. “It was the patterns of their selections that guided the future evolution of the hat, not the reasons for their selection [conscious or otherwise]….. The action of that selection is the only thing that makes an impression on the evolution of cowboy hat design as it continues its almost imperceptible shuffle into an unknowable future” (p. 96). It is important to note that fancy as well function may have critically participated in the evolution of the cowboy hat, fancy being the key selective force that Darwin famously offered in connection with the process of sexual selection.

Ideas

Hughes further flouts convention with his reconsideration of ideas: “We have the impression that invention, intention, and conscious decision making play a crucial part in crafting our humanity, but perhaps that just isn’t so. Perhaps the evolution of [ideas] can only ever be described as mindless” (p. 96). For Hughes, ideas “evolve like independent beings … mindlessly, accidentally/automatically as their generations navigate a path, any path, through the selective environment we consciously/subconsciously/unconsciously create” (p. 100).

How does Hughes’ reconsideration of ideas relate back to design? If hats and barns and other human artifacts can emerge through a mechanical evolutionary process, “if everything we hold dear can come about mindlessly, just as species do in nature, then we [as intelligent agents] could be out of a job: cultural Life could evolve quite happily without any conscious participation on our part. As long as we host the Ideas, and complacently pass them on to others, and select some Ideas in favor of others for whatever reason … human culture will come to possess all the characteristics of a capitalized Life” (p. 104). Hughes notes that if we were to accept this unorthodox view of cultural evolution, then we ourselves could be seen to be, “smart but unquestioning Idea machines hosting an auto-evolving culture as it continues its pointless, almost imperceptible shuffle to nowhere” (p. 104).

To many, Hughes’ conceptualization of human culture will represent a most distressing possibility. “It takes the value and purpose out of everything we do…. Can’t we be consciously, actively, creatively employed somehow, driving cultural evolution, steering humanity?” (p. 105). Perhaps we can, particularly when we base our current efforts on the accumulated successes and failures of our predecessors; but, asserting that we routinely do may be too simple and arrogant an interpretive course to follow. If we seriously entertain Darwinian selectionism and strictly apply it to what we make and do, then we must expand the scope of our inquiry and more assiduously and relentlessly explore the origins of our behaviors and inventions.3

Inventions

To illustrate this point, Hughes suggests that we consider two instances which suggest that intelligent design may be overrated. Perhaps the role of trial and error is too often overlooked as is the part played by accident (Simonton, 2012).

First, consider the telephone. While Alexander Graham Bell was at work experimenting

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3 Skinner (1974), too, emphasized that novel and creative behaviors can mindlessly arise from both contingencies of survival and contingencies of reinforcement. In our efforts to explain the nature of novel and creative behaviors, Skinner urged us to remember that: “The key word in Darwin’s title was ‘origin’” (p. 224).
on the telegraph to see if it could be modified to carry multiple messages—what he called a "harmonic telegraph"—he was concurrently exploring the possibility of electrically transmitting sound over a wire. In the process of that exploration, "when Bell heard the overtones of [a] single reed twanged accidentally by [his assistant Thomas] Watson in 1875, what was a giant leap for humankind was merely a small step for Bell" (p. 132). Why? Hughes' answer: "[Because Bell had] built lots of models, chosen those that worked best, and tweaked each of those winning designs in order to make the next generation of design. Over time, the models had gradually gotten better at being a telephone. He'd 'bred' the telephone just as dog breeders in Britain bred the cocker spaniel" (p. 133), although neither Bell nor those British dog breeders may ever have had a clear vision at the outset of what specific outcome—cocker spaniel or telephone—would materialize from their trial-and-error "breeding" process.

Second, consider the theory of evolution through natural selection. Hughes proposes: "Darwin didn’t have a brilliant Idea; the Idea had a brilliant Darwin" (p. 140). Hughes observes that the theory of evolution by natural selection did not suddenly, spontaneously, and miraculously flash into Darwin’s mind; it had a long and tortuous gestation period, famously encompassing most of his adult life (not to mention the contributions of many earlier thinkers, from Aristotle to Darwin’s grandfather Erasmus). Nor was Darwin’s own theory hatched fully fledged; it was extensively revised in six editions of On the Origin of Species from 1859 to 1872.

The case of Darwin and his theory of evolution by natural selection does lead Hughes to see a place for what many call "human genius" in a Darwinian world; it represents the rare situation in which the evolution of an idea takes place in just one mind rather than in many.4 Nevertheless, "the adaptation that happens within a mind is the same as the adaptation that happens between minds; it’s survival of the fittest, good old-fashioned Darwinism. We are not just Idea vehicles, conveyors of thoughts from one person to the next. We can, individually, make a considered difference. The capacity for genius is there within all of us; it’s not the preserve of the few” (pp. 147–148; for more on creativity as ordinary problem solving, see Weisberg, 1987, 1993). Still, such celebrated cases of individual invention seem to be the exception rather than the rule of cultural evolution.

The wheel may exemplify the rule. Of course, we do not know who invented the wheel, when it was invented (some say as long ago as 9,500 BC), and what various functions it might have served as it evolved. Yet, Hughes does propose a plausible scenario for the wheel’s gradual evolution as a means of transport. Why might the wheel have undergone a long evolutionary process? “Because Ideas evolve accidentally/automatically like living things, and that takes a long time. . . . The invention of the wheel was a routinely get-rich-slow affair” (p. 185).

The Origin of Tepees

Finally, Hughes arrives at the focus of his inquiry into cultural evolution—the tepee. What was its origin? “It’s bound to have been a gradual tepee dawning—shuffle steps the whole way. That’s the way evolution is. So gradual, in fact, that it’s impossible to spy an origin at all. Every conical tent Idea in the tepee’s ancestry . . . would have been able to ‘breed’ with the one that came before it and the one that came after it. It’s only after the event, in retrospect, that you can declare, ‘Hey, it’s happened.’ Because Ideas are like species, there was no definitive ‘origin’ of tepees” (p. 258).

Thus, the tales of cultural evolution can be as frustratingly incomplete and inconclusive as the tales of biological evolution. Nevertheless, the power of the parallel is considerable and it is one to which I will return after considering the process of behavioral innovation.

ON THE ORIGIN OF NOVEL BEHAVIORS

As exemplified by the various topics in Hughes’ book, innovation is usually associated with the things we make: the wheel, the tepee,

4 We should not forget Darwin’s contemporary, Alfred Russel Wallace, as a second evolutionary pioneer. Both Darwin and Wallace presented their similar evolutionary theories to a meeting of the Linnaean Society in 1858. Even earlier, in 1844, Robert Chambers anonymously published his evolutionary speculations, Vestiges of the natural history of creation, which influenced both Darwin and Wallace (Secord, 1994).
the telephone, the electric light, the internal combustion engine, the computer mouse. Far less attention is generally paid to the innovative things we do, even though behaviors are responsible for making all of those wonderful things that enhance our lives.

Discovering the origins of novel behaviors turns out to be an extremely challenging enterprise (Epstein, 1991; Marr, 2003), but there are nevertheless a few illuminating instances that speak directly to many of Hughes’ controversial contentions concerning culture, selection, design, ideas, and inventions. I have recently come across what many experts deem to be the two most important innovations in thoroughbred racing: the monkey crouch and acey-deucey. I believe that the provenance of these behavioral innovations supports the involvement of variation and selection in the creation and propagation of adaptive behavior, whether that is the behavior of an individual or the behavior of a social group, such as professional jockeys.

So, indulge me for a moment and imagine the crimson-clad bugler standing trackside blaring the traditional Call to the Post. Now, imagine the string of spirited thoroughbreds being led by their handlers into the starting gate. After all of the steeds are at last loaded, the doors of the gate suddenly snap open. “And, they’re off!”

The Monkey Crouch

One of the first things that you notice as the horses on the track flash by you is the jockeys’ scrunched posture atop their mounts. This awkward riding position, called the monkey crouch, is the universal style at today’s race-tracks. In fact, it has been the dominant style for 100 years. But, the monkey crouch was not always the rider’s preferred position. Up until the end of the nineteenth century, jockeys rode rigidly upright with their legs fully extended into long stirrups. Then, a rapid evolutionary process transpired—the monkey crouch was the result.

Biomechanists have recently explained how the monkey crouch succeeds in producing faster racing speeds (Pfau, Spence, Starke, Ferrari, & Wilson, 2009). At the expense of a far more arduous ride for the jockey than the earlier, upright style, the monkey crouch confers substantial locomotor benefits for the horse as well as affording a smaller advantage in wind resistance for the horse and rider. This new riding style produced measurable speed benefits to the race winners at the English Epsom Derby Stakes from 1900 to 1910 (Pfau et al.).

The dramatic change in riding style across a decade of different jockeys prompts the question: How did the monkey crouch originate? Many sportswriters credit two American jockeys—Willie Simms and Tod Sloan—with popularizing this innovative riding position, bringing it across the Atlantic to England in 1895 and 1897, respectively. Interestingly, English rider Harding Cox claims to have adopted the monkey crouch even earlier. As well, Cox provides unique personal insights into the provenance of the posture.

In his 1922 memoir, Chasing and Racing, Cox describes how he happened upon the position and what benefits he believes it conferred: “When hunting, I rode very short, and leaned well forward in my seat. When racing, I found that by so doing I avoided, to a certain extent, wind pressure, which . . . is very obvious to the rider. By accentuating this position, I discovered that my mount had the advantage of freer hind leverage. Perhaps that is why I managed to win on animals that had been looked upon as ‘impossibles,’ ‘back numbers,’ rogues and jades. My theory was endorsed by Tod Sloan himself [who when riding in this crouched position] managed to win on horses which had erstwhile been regarded as only fit for cats’ meat” (pp. 212–213).

Although Pfau et al. (2009) emphasized the biomechanical benefit to the horse of the jockey’s crouched posture and they deemphasized the role played by decreased wind resistance, Cox’s own narrative provides clues concerning this innovation’s origins: decreased wind resistance may have initially encouraged Cox’s forward adjustment on the horse, which allowed his later accentuation of the posture into the fully realized monkey crouch. Much as a scaffold provides a temporary structure for the construction of a building, Cox’s initial adjustment to wind pressure may have scaffolded his later behav-

5 Some commentators have speculated that Simms and Sloan may have modeled their “novel” riding style from Native American horsemen who rode bareback, thereby turning the evolutionary clock ever further back. However, there is little support for this possibility.
ioral transition to a novel riding style—one that transformed thoroughbred racing.

Obvious questions nevertheless arise: Did Cox intend to design a new riding position? Did he purposefully reposition himself on his horse after making painstaking mathematical calculations? Did he assiduously record wind pressure scores or take precise biomechanical readings to assess the effectiveness of his new riding style? Did he foresee what the end result would be of his extemporaneous equestrian experiments? Certainly not. Rather, he probably proceeded by trial and error. Moreover, both he and other jockeys undoubtedly noticed the salutary effects of this new and unconventional style on Cox’s racing results, thereby explaining his embracing this posture and others’ quickly copying it to similarly good effect.

Although novel behaviors are usually attributed to creativity or to genius, a more mundane account may suffice. The origin of the monkey crouch nicely fits the law of effect: Successful behavioral variations are retained, whereas unsuccessful variations are not. This lawful selective reinforcement process may produce human innovations much as the lawful process of natural selection may produce novel organisms (Wasserman & Blumberg, 2010).

Acey-Deucey

A much subtler innovation can also be spotted at the racetrack, but it requires viewing horse and jockey directly from the front or from the rear: the jockey’s left stirrup is often placed from 2 to 12 inches lower than the right. This so-called acey-deucey style of uneven stirrup placement is believed to confer important advantages on oval tracks, where only left turns are encountered in counterclockwise races (English races are run clockwise, thereby reversing the relative lengths of the stirrup leathers to contend with right turns only). Although science does not yet appear to have systematically studied the effectiveness of this racing practice, some observers suspect that the acey-deucey style permits the horse and rider to lean more effectively into the turns by providing the duo with better balance and strength, arguably the optimal formula for harnessing the centripetal force of a tight turn (Harzmann, 2002).

Who was responsible for this important racing innovation? And, how did it originate? Most sportswriters have credited the famous jockey Eddie Arcaro with perfecting and popularizing acey-deucey in the 1940s. However, Arcaro himself never took credit for this innovation and he professed to having no idea who coined the term (Georgeff, 2003).

The more likely developer of riding acey-deucey was Arcaro’s contemporary, Jackie Westrope. Known as “The Rope,” Westrope was one of America’s most prodigious jockeys; in 1933, at the age 15, he had already won 301 races! Although a few other jockeys were already riding with the left stirrup a little lower than the right, Westrope dropped it dramatically lower. Some observers in fact reported that: “His left leg was completely straight and his right knee was under his chin” (Harzmann, 2002).

Had Westrope conducted careful experiments or had he examined extensive film records in a deliberate plan to outrun his racing rivals? No. Another famous contemporary jockey, Bill Shoemaker, related just what led Westrope to take acey-deucey to such extreme lengths: “He did it after he came back from getting hurt one time, and he couldn’t bend his left knee all the way. His balance was still good, though, and other guys started copying him” (Hovdey, 2002).

A gimpy left leg that resulted from a starting gate misadventure thus led to Westrope’s off-kilter racing style that accidentally coincided with enhanced left-hand turning performance. Now, that’s serendipity! What was not serendipitous was the rapid and widespread adoption of the acey-deucey racing style by many of Westrope’s competitors, a style which continues in thoroughbred racing to this day.

KEY ISSUES IN THE DEVELOPMENT AND EVOLUTION OF BEHAVIOR

Hughes considered cultural evolution to be analogous to biological evolution and for natural selective pressures to be at work in both. I just suggested that the law of effect may be a prime participant in the development of adaptive behavior for both individuals and social groups. Additional concepts and analogies are relevant to the development and evolution of adaptive behavior; some were encountered in our earlier discussions of culture, design, and invention, and they merit deeper consideration in this review. I thus turn to the analogy between natural selection and artificial selection as well
as to the analogy between the law of natural selection and the law of effect; these analogies in turn prompt critical consideration of purpose, design, and agency, all matters which were also important to Hughes.

The Analogy between Natural Selection and Artificial Selection

As noted earlier, Darwin laid the groundwork for his theory of evolution through natural selection by drawing an analogy with artificial selection. In the same way as humans produce new breeds of plants and animals via selective breeding techniques (artificial selection), so natural selection via the "struggle for existence" produces new species—organisms "made by man and nature," respectively, in Darwin's own words (Transmutation Notebook C106; quoted by Evans, 1984, p. 123). The apparently purposeful "picking" of individual organisms to genetically contribute to future generations is taken for granted in the case of humans selectively breeding plants and animals; after all, most authors unquestioningly deem humans to be autonomous intelligent agents who can rationally choose among alternatives with foreseeable ends in mind. But, in what sense is it appropriate to conceive of nature in an analogous way?

Darwin (1958) addressed this question in his Autobiography: "The old argument of design in nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings and in the action of natural selection, than in the course which the wind blows. Everything in nature is the result of fixed laws" (p. 87). In this way, Darwin explicitly rejected any notion that natural selection involves intelligent designing or selecting by a supernatural being.

Darwin himself said nothing more about how humans actually came to make things like door hinges. Today's most prominent evolutionist, Richard Dawkins, did engage this issue by likening natural selection to a blind watchmaker. "All appearances to the contrary, the only watchmaker in nature is the blind forces of physics, albeit deployed in a very special way. A true watchmaker has foresight: he designs his cogs and springs, and plans their interconnections, with a future purpose in his mind's eye. Natural selection, the blind, unconscious, automatic process which Darwin discovered, and which we now know is the explanation for the existence and apparently purposeful form of all life, has no purpose in mind. It has no mind and no mind's eye. It does not plan for the future. It has no vision, no foresight, no sight at all. If it can be said to play the role of watchmaker in nature, it is the blind watchmaker" (1986, p. 5).

Dawkins thus views human watchmakers as consciously plying their trade with foresight and purpose. His account may suffice for individuals having little interest in uncovering the origins of timepieces and timekeeping; but, it cannot suffice for a natural science of behavior. Whether one can translate Dawkins' mentalistic ideas into plausible behavioral terms is not the main problem; Skinner (1989) outlined how this task might be undertaken. Rather, the greater problem is whether such mentalistic ideas represent real explanations of behavior. Skinner (1963) claimed that they do not and he further contended that such so-called "mental way stations" might actually deter attempts to delve deeper into the origin of such human endeavors as timekeeping, much as did Darwin when he sought the origin of species.

On the Origin of Artificial Selection

Darwin famously deemed natural selection to be analogous to artificial selection. As to the process responsible for the origin of species, he theorized that the law of natural selection promotes the survival and reproduction of some, but not all variants. No intelligent agent purposefully selects and breeds those variants according to a premeditated design or end.

What about the process of artificial selection? In this case, it certainly appears that today's plant and animal breeders consciously and purposefully plan their breeding regimens to produce desired results: disease- and pest-resistant wheat, more productive cows and hens, etc. But, did human beings practice such apparently purposeful selection from the
inception of plant and animal breeding? If not, then how might we have developed the very breeding techniques that played such a pivotal role in Darwin’s theorizing about the origin of species? And, what lessons might we now learn by considering the provenance of artificial selection?

Let me get straight to the point. Artificial selection might itself have been selected by another ostensibly purposeless, mindless process—the law of effect. That is correct. Artificial selection—the apparently purposeful, foresightful process that is routinely claimed to differ so sharply from natural selection because of the involvement of intelligent human agents—may originally have been neither purposeful nor foresightful. Who would countenance such a counterintuitive notion? In fact, it was none other than Charles Darwin! Darwin pointed to what he called “unconscious” selection as another means of breeding animals, which might very well be claimed to be the probable precursor to “conscious” or premeditated selection.

Evans (1984) has assiduously chronicled Darwin’s extensive research into the practice of selective breeding. Darwin himself justified the systematic study of artificial selection because it was so important to his own evolutionary theorizing. Fifteen years prior to publication of On the Origin of Species, Darwin observed that, “All my notions about how species change are derived from long-continued study of the works of agriculturists and horticulturists” (quoted by Evans, 1984, p. 114). Indeed, the same year in which he published the Origin, Darwin noted that, “I came to the conclusion that selection was the principle of change from the study of domesticated productions; and then, reading Malthus, I saw at once how to apply this principle” (quoted by Evans, 1984, p. 114).

But, Darwin gleaned even more from his painstaking study of artificial selection than his groundbreaking law of natural selection. Burnett (2009) recently highlighted Darwin’s further suggestion that artificial selection need not be practiced with methodical rigor or with a clear end in mind. In such cases, Darwin suggested that people practiced unconscious selection.

Here is how Darwin introduced unconscious selection: “At the present time, eminent breeders try by methodical selection, with a distinct object in view, to make a new strain or sub-breed, superior to anything existing in the country. But, . . . a kind of Selection, which may be called Unconscious, and which results from every one trying to possess and breed from the best individual animals, is more important. Thus, a man who intends keeping pointers naturally tries to get as good dogs as he can, and afterwards breeds from his own best dogs, but he has no wish or expectation of permanently altering the breed. Nevertheless I cannot doubt that this process, continued during centuries, would improve and modify any breed, in the same way as Bakewell, Collins, &c., by this very same process, only carried on more methodically, did greatly modify, even during their own lifetimes, the forms and qualities of their cattle” (1859, p. 34).

Darwin’s casual use of terms like “trying,” “intending,” “wishing,” and “expecting” do not accord with the lack of conscious planning. He did provide another example of unconscious selection drawn from observing the natives of Tierra del Fuego: “If there exist savages so barbarous as never to think of the inherited character of the offspring of their domestic animals, yet any one animal particularly useful to them . . . would be carefully preserved . . . and such choice animals would thus generally leave more offspring than the inferior ones; . . . in this case there would be a kind of unconscious selection going on” (1859, p. 36).

However, Darwin’s clearest example of unconscious selection is an exotic breed of pigeon—the fantail. Today’s pigeon fanciers might be said to try to maintain or to improve their stock of fantails by means of consciously purposeful selective breeding. Yet, Darwin warns us that the creation of fantails represents an entirely different matter: “to use such an expression as trying to make a fantail, is, I have no doubt, in most cases, utterly incorrect. The man who first selected a pigeon with a slightly larger tail, never dreamed what the descendants of that pigeon would become through long-continued, partly unconscious and partly methodical selection” (1859, p. 39). Think of the fantail as today’s Stetson of pigeons!

Contained within Darwin’s keen observations and speculations lies an important clue concerning the possible origins of modern selective breeding techniques. Perhaps humans’ earliest breeding practices involved
neither purpose nor design. Instead, the initial random breeding of plants and animals might have produced a few variants which were more advantageous to the human breeders. Later nonrandom or selective breeding—even of the unconscious kind—might have produced still more successful variants, thereby reinforcing those effective breeding techniques and producing even better adapted offspring, etc. Explicit rules of selective breeding might subsequently have been developed, thereby enhancing the breeding practice and leading to their perpetuation via the spoken or written word. Rules such as these represent “powerful exemplars of the advantage of a verbal repertoire over acquiring behavior through direct contact with natural contingencies” (Marr, 2003, p. 22).

It is important to appreciate two special senses of adaptation that may participate in artificial selection: use and fancy. Darwin (1859) observed that: “One of the most remarkable features in our domesticated races is that we see in them adaptation, not indeed to the animal’s or plant’s own good, but to man’s use or fancy” (p. 33). Here, it is vital to stress that breeding for fancy may sometimes produce animals of dubious, if not dramatically declining fitness, as in the unfortunate case of today’s bulldogs (Denizet-Lewis, 2011).

To be sure, there is nothing artificial about the biological mechanisms of inheritance or the cumulative effects of differential reproduction in the selective breeding of plants and animals by humans. Nor do humans in any way exist apart from nature. “Because human beings are ... part of nature, their selective [breeding] practices cannot in any significant sense be understood to fall outside of nature: artificial selection is by these lights just a peculiar variety of ‘natural selection’” (Burnett, 2009 p. 124).

Finally, as was the case for the origin of species, Darwin was acutely aware of how little we know about the origin of domestic breeds; he was also aware of how little we know about the origin of breeding techniques. Darwin contemplated the problem of determining the origins of domestic breeds and breeding practices, and noted that inherited variations may change only slightly from generation to generation over many years: “But, in fact, a breed, like a dialect of a language, can hardly be said to have had a definite origin. A man preserves and breeds from an individual with some slight deviation of structure, or takes more care than usual in matching his best animals and thus improves them, and the improved individuals slowly spread in the immediate neighbourhood. The principle ... of unconscious selection will always tend ... to add to the characteristic features of the breed, whatever they may be. But the chance will be infinitely small of any record having been preserved of such slow, varying, and insensible changes” (Darwin, 1859 p. 43). For these reasons, ascertaining the origin of selective breeding techniques is as devilishly difficult to divine as ascertaining the origin of tepees.

Intelligent Design in Natural Selection, Artificial Selection, and Operant Conditioning

Darwin famously disavowed the involvement of any intelligent agent or omniscient designer in the evolution of species. He believed that the blind, unconscious force of nature via the struggle for existence was sufficient to account for the process of speciation.

Turning to artificial selection, Darwin recognized that the process of unconscious selection might have lain at the root of what later developed into the advanced cultural practice of selective breeding that followed humans’ domestication of plants and animals. These points suggest that natural selection and artificial selection may not be analogous processes at all; rather they may simply be different versions of a single selection process involving different vectors of selection operating over dramatically different time scales (Burnett, 2009). Darwin’s writings do not decisively distinguish these possibilities.

It is of particular note that Darwin was receptive to the possibility of unconscious selection participating in the case of selective breeding. Nonetheless, Darwin does not appear to have entertained the related possibility of unconscious selection participating in other instances, such as humans’ making the hinge of a door. But, what if we were to take the bold step of extending the reach of selectionist thinking to such human innovations as making the door hinge, fabricating the telescope, dancing the moonwalk, or speaking in Pig Latin?

We should then have to give serious consideration to the possible participation of the law of effect: the blind, unconscious,
automatic process through which behaviors are strengthened (or weakened) by the reinforcers (or punishers) that follow them. This basic behavioral law was discovered by Edward Thorndike and it served as the foundation of Skinner’s behavior theory. Critically, for neither Thorndike nor Skinner was the behaving organism itself the selecting agent for the emergence of a learned behavior. Rather, environmental contingencies shape behavioral change: Alterations in the relationship between response and outcome produce adaptive changes in behavior—a positively Darwinian process (Dennett, 1975).

Thorndike’s discovery of the law of effect followed Darwin’s death by 16 years; we cannot hold him responsible for not knowing about it. But, Dawkins (2001) was well aware of the law of effect; he even argued that its application to human behavior could shape such dastardly acts as suicide bombings. Still, Dawkins appears not to have fully embraced this powerful principle when discussing the role of design in the creation of natural and artificial things.

One prong of Dawkins’ argument is that natural things are not made by an intelligent designer. Dawkins appreciates that this is an extremely difficult point for most people to accept because: “Our world is dominated by feats of engineering and works of art. We are entirely accustomed to the idea that complex elegance is an indicator of premeditated, crafted design. This is probably the most powerful reason for the belief, held by the vast majority of people that have ever lived, in some kind of supernatural deity. It took a very large leap of the imagination for Darwin . . . to see that . . . there is another way . . . for complex ‘design’ to arise out of primeval simplicity. A leap of imagination so large that, to this day, many people seem still unwilling to make it” (Dawkins, 1986, p. xii).

But, perhaps there is another “leap of the imagination” that is so large that even Dawkins may be unwilling to make it: namely, that what we make and do, however complex, may also have arisen out of primeval simplicity. Here, Dawkins offers the second prong of his argument: Just as “true watchmakers” have built timepieces, we humans have consciously, purposefully, and foresightfully designed the artificial things that surround us. This claim seems to be a truism. But, what do we actually know about the origins of those things? And, does simply asserting that intelligent designers crafted them with premeditation suffice to explain their creation?

Consider Dawkins’ account of the current practice of building an airliner, an entity that is so complex that no single person may know all of the details of its design, fabrication, and operation: “However incompletely we understand how an airliner works, we all understand by what general process it came into existence. It was designed by humans on drawing boards. Then other humans made the bits from the drawings, then lots more humans (with the aid of other machines designed by humans) screwed, rivetted, welded or glued the bits together, each in its right place. The process by which an airliner came into existence is not fundamentally mysterious to us because humans built it. The systematic putting together of parts to a purposeful design is something we know and understand, for we have experienced it at first hand, even if only with our childhood [construction toys]” (Dawkins, 1986, p. 3).

Perhaps in writing for a general audience, Dawkins may have leaned too heavily on intelligent design to explain the origin of humanmade things; Skinner (1963) did warn us that mental way stations such as foresight “are so often simply invented” (p. 957). Surely, Dawkins’ account cannot stand as a suitable explanation for the creation of an airliner. It ignores the richness and intricacy of the airliner’s protracted provenance, spanning decades of celebrated successes and vastly more forgotten failures; it also ignores the creation of drawing boards, pencils, rules, screwdrivers, rivets, glue, etc. Indeed, invoking an intelligent human designer may add as little to our understanding of the origin of artificial things as creationists’ invoking an intelligent divine designer adds to our understanding of the origin of natural things. Both may be considered to naively equate “complex elegance” with “premeditated, crafted design.”

Pursuing an entirely different theoretical approach, the law of effect suggests that the things we do and make, including airliners, may have had their origins in a mechanical, trial-and-error process. Such selection by consequences can unfold within individual lifetimes as well as across many generations thanks to oral traditions, written words, and detailed drawings, themselves the result of selection by consequences. This protracted selection process may even produce aircraft as
complex and amazing as the space shuttle. However, lest one accept the infallibility of humans’ intelligent designs, do recall the fate of the Challenger on January 28, 1986 and the Columbia on February 1, 2003. No matter how determinedly humans endeavor to engineer the end of failure, this goal seems tragically to elude our grasp (Petroski, 2012).

The Analogy between the Law of Natural Selection and the Law of Effect

Yet a second relevant and important analogy can be drawn in our consideration of the development and evolution of adaptive behavior; namely, between the law of natural selection and the law of effect (Ringen, 1993; Skinner, 1974; Smith, 1983). In About Behaviorism, Skinner (1974) carefully developed this analogy as well as emphasized the parallel between behavioral selection operating within the lifetime of an individual organism and behavioral and/or anatomical selection operating across the lifetimes of many related organisms.

Skinner saw Darwin as replacing a purposeful intelligent deity with a natural selective process to produce change. “Evolutionary theory moved the purpose which seemed to be displayed by the human genetic endowment from antecedent design to subsequent selection by contingencies of survival” (Skinner, 1974, p. 224). Behavior theory involved a similar replacement; here, the purposeful intelligent mind was replaced by a different, but no less natural selective process. “Operant theory moved the purpose which seemed to be displayed by human action from antecedent intention or plan to subsequent selection by contingencies of reinforcement” (Skinner, 1974, p. 224).

A key problem for both the evolution of species through the law of natural selection and behavioral change through the law of effect is the emergence of novel structures or behaviors. Skinner (1974) noted that contingencies of reinforcement resemble contingencies of survival in producing novel behaviors. “Natural selection explained the origination of millions of different species on the surface of the earth, without appealing to a creative mind” (p. 224). In the case of human behavior, “contingencies of reinforcement may explain a work of art or a solution to a problem in mathematics or science without appealing to a different kind of creative mind or to a trait of creativity” (p. 224).

To further develop his analysis, Skinner (1974) observed that, “As accidental traits, arising from mutations, are selected by their contribution to survival, so accidental variations in behavior are selected by their reinforcing consequences” (p. 114). Acey-deucey and the monkey crouch may be seen to have arisen from such accidental variations. Whether behavioral variations are entirely accidental and can effectively account for all instances of novel or creative behaviors has not yet been determined; the mechanisms of behavioral variation have received far too little experimental attention at this point in time to be sure (Epstein, 1991). 7

Skinner’s controversial proposals can then be seen to apply the kind of selectionist interpretation that Darwin had offered for biological evolution to the behavior of organisms. Ringen (1993) thus observes that: “According to Skinner, vitalistic explanations of organic structure and development are related to explanations in terms of natural selection (and relevant biochemical processes) in the same way that mentalistic explanations of behavior are related to explanations in terms of operant conditioning (and relevant physiological processes). Skinner suggested that in light of these analogies, the success of Darwinism and the demise of vitalism in scientific biology provide a lesson for scientific psychology. Mentalism, like vitalism, is a scientific cul de sac... Darwin’s crucial methodological innovation was to suggest a new ... way of explaining function, goal direction, and adaptation without appeal to intelligent agency or the mentalistic concepts that such appeals suggest” (p. 4).

Consider as well Smith’s (1983) striking synopsis of the analogy between the law of natural selection and the law of effect: “Natural selection is to the origin of species as operant conditioning is to the origin of behavior... Just as Darwin’s theory purports to account for the presence of design in the organic world without positing a cosmic intelligence, so Skinner’s theory purports to account for the presence of design in behavior

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7 See Campbell (1960) and Simonton (1999) for more about the role of so-called “blind” variation and selection in human creativity. And, see Neuringer and Jensen (2010) for comparative empirical research engendering behavioral variation by contingent reinforcement.
without positing a personal intelligence. Both theories attempt to circumvent assuming the existence of agents that hold goals and choose among alternative courses of action to attain them. The strategy in both cases is the same: the appearance that a given adaptive process is controlled by the purposeful pursuit of a certain goal is explained on the basis of prior environmental contingencies. The result is the exit of God and/or purposive forces from biology, and (so the analogy goes) the exit of self and/or intentions from psychology... Natural selection is to purpose in evolution as operant conditioning is to purpose in behavior" (pp. 136–137).

CONCLUDING COMMENTS

In this review, I have considered three important analogies: (a) between natural selection and artificial selection, central to Darwin’s theory of biological evolution; (b) between the law of natural selection and the law of effect, central to Skinner’s theory of operant behavior; and (c) between biological evolution and cultural evolution, central to Hughes’ speculations on the origin of tepees and other human devices. Before closing, I will comment a bit more about each.

Natural Selection and Artificial Selection

Having proposed that natural selection and artificial selection are not analogous processes, but are instead different versions of a single selection process, Burnett (2009) proposed that we should not view ourselves as distinct from nature, a perspective which has “staggering” weight. Specifically, we can no longer see ourselves as distinct from a nature that may be “without mind, without agency, without intelligence” (p. 124).

Of course, denying ourselves mind, agency, and intelligence is unimaginable to many, including Burnett, who opined that, “it would be quixotic (though perhaps intriguing) to try to write off rational forethought altogether” (personal communication, July 5, 2010). Quixotic or not, I believe that it is perfectly reasonable at least to explore the possibility of a behavioral science that divests itself of these mentalistic notions much like modern biology divested itself of vitalistic notions (Cashmore, 2010).

Beyond research in human operant conditioning (e.g., Hefferline, Keenan, & Harford, 1959; Lieberman, Sunnucks, & Kirk, 1998; Svartdal, 1992), investigators from diverse realms of psychological science have shed fresh light on the possible relationship between awareness and behavior. In his classic paper, “The mind’s best trick,” Wegner (1993) said of the relation between thought and action: “We should be surprised... if cognitive creatures with our demonstrably fallible self-insight were capable of perceiving the deepest mechanisms of our own minds. The experience of conscious will is a marvelous trick of the mind, one that yields useful intuitions about our authorship—but it is not the foundation for an explanatory system that stands outside the paths of deterministic causation (Wegner, 1993, p. 68).” More recently, Custers and Aarts (2010) observed that: “The basic processes necessary for goal pursuit—preparing and directing instrumental actions and assessing the reward value of the goal—can operate outside conscious awareness (p. 50).” A dramatically different approach to understanding human action is needed: one which uses the methods of natural science and eschews the teleology of folk psychology (Moore, 2008; Osler, 2001). Behaviorism is well positioned to fill that bill (Wasserman, 1999).

The Law of Natural Selection and the Law of Effect

Moving to the second analogy, we have seen that the law of natural selection and the law of effect entail similar processes: variation, selection, and retention. Both selectionist laws contribute to an organism’s fitness in the face of challenging and changing exigencies of survival. In neither case is an intelligent agent doing the selecting, is a future goal in mind, or is anything else needed to explain change over time than the processes of chemistry and physics. The law of natural selection and the law of effect may differ, however, in the particulars of variation, selection, and retention.8

8 For example, one might suggest that biological change occurs through undirected, random variation, but that in the case of human behavior, variation may be constrained and directed by the task at hand (M. J. Marr, personal communication, April 17, 2012; B. Schwartz, personal communication, December 7, 2011). One might also suggest that Darwinian replication holds for biological evolution, whereas Lamarckian replication holds for operant conditioning and cultural evolution (Moore, 2008). For other possible disparities, see Epstein (1991), Marr (2003), and Segal (1972).
Biological Evolution and Cultural Evolution

For Hughes, ideas evolve just as do species. Unfortunately, studying the evolution of species and ideas is particularly difficult, as Skinner (1981) noted: “Biologists and anthropologists study the processes through which variations arise and are selected, but they merely reconstruct the evolution of a species or a culture. Operant conditioning is selection in progress. It resembles a hundred million years of natural selection or a thousand years of the evolution of a culture compressed into a very short period of time” (p. 502).

The monkey crouch and riding acey-deucy represent illuminating instances in which one can follow the development of an innovative behavior in an individual person as well as trace its evolution in a social group over a relatively short time interval. Such cases suggest that cultural evolution can be studied along timescales which are not as protracted as Skinner feared. Nevertheless, the lack of experimental control and contemporaneous behavioral recording render any historical reconstructions suggestive rather than authoritative accounts of cultural evolution (Epstein, 1991; Simonton, 2012).

A Natural Science of Behavior

To close, consider this recent appraisal of Darwin’s impact on biological science by Ayala and Avise (2009): “Darwin completed the Copernican Revolution by drawing out for biology the notion of nature as a lawful system of matter in motion that human reason can explain without recourse to supernatural or extranatural agencies” (p. 2475).

Can we bring psychological science into such a lawful system of matter in motion and explain human action without recourse to nonbiological agencies? I hope so, but this task will be extremely difficult as long as such notions as “mind,” “consciousness,” and “executive control” continue to rule the theoretical realm of psychology. From this vantage point, Hughes’ Origin of Tepees represents a fresh and bold consideration of mindless design in human culture.

REFERENCES


Received: December 1, 2011
Final Acceptance: June 13, 2012