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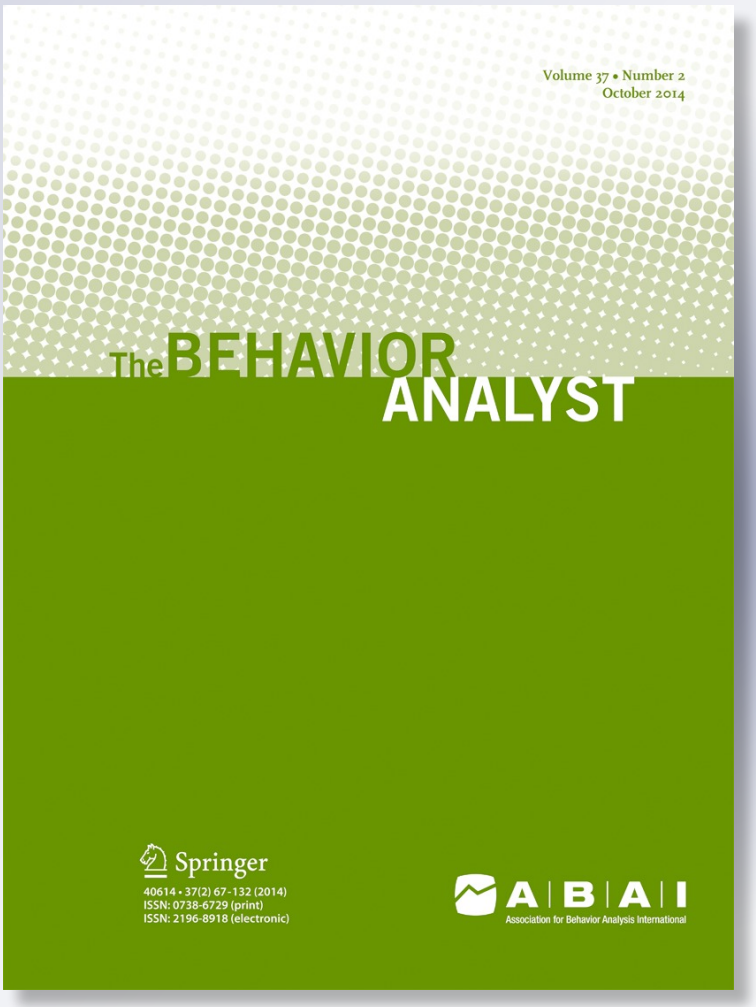

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BOOK REVIEW

The Outside Story: a Review of *Beyond the Brain*: *How Body and Environment Shape Animal and Human Minds*, by Louise Barrett

Timothy D. Hackenberg

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> Our tendency to focus only on what's going on in an animal's head when we seek to understand how and why it behaves, means that we fail to notice the extent to which the structure of the environment and the physical shape of the animal's body play an active role in shaping its behavior. (p. 47)

This passage captures well the perspective of Louise Barrett's book, *Beyond the Brain*: *How Body and Environment Shape Animal and Human Minds* (2011). It is a perspective that is action-oriented and environment-based, a perspective that has much in common with behavior analysis. My aim in this review is to point out some of these commonalities and to suggest some ways in which the approaches might profitably be combined.

These commonalities are not hard to find, as Barrett's writing, both here and elsewhere (Barrett, 2012), reveals a keen understanding of Skinner and behavior analysis. To begin with, Barrett is strongly opposed to dualism (splitting the world into body and mind) and mentalism (appealing to states of the mind to explain behavior). These views are likely to strike a responsive chord with behavior analysts, who similarly reject these types of explanation. But more than simply joining forces with behavior analysts in opposition to conventional views, Barrett outlines an alternative approach to explaining complex behavior that not only is compatible with behavior analysis but also extends this line of thinking in fresh new directions. My second aim is to point out some of these new areas of potential contact with behavior analysis, with the hope of furthering a productive interdisciplinary dialogue.

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Bottom-up and Outside-in

One of the most powerful ideas Barrett explores is that complex behavior can arise from simpler processes. The book is filled with compelling examples of such bottom-up (simple to complex) thinking, exemplified in the *parable of the ant*, attributed to Herbert Simon, according to which the complex navigational paths an ant follows may seem to reflect complex internal rules and mechanisms but, in reality, reflects the complex terrain of the environment. As Barrett says, "Put more generally, the parable of the ant illustrates that there is no necessary correlation between the complexity of the observed behavior and the complexity of the mechanism that produces it" (p. 42).

This point is further illustrated in several sketches of autonomous robots—all of which use simple computational rules that guide the robot's behavior locally, without the need for complex internal mechanisms. For example, one type of small robot on wheels is programmed to behave according to a simple rule: avoid objects. Because its two sensors are positioned on each side of its body, the robot moves left when it encounters an object on its right and moves right when it encounters an object on its left. When placed in an environment

with other similar robots and some cubes scattered about, something quite unexpected happens. The robots cluster the cubes together, *as if* they are tidying up the workspace. (Indeed, the robots have been dubbed "Swiss robots" for their seeming affinity for neatness.) But the tidying is not programmed into the robots; rather, it grows out of their body architecture and interactions with the environment. Like the ant, the complex behavioral output arises from the local interaction of simpler processes. Looking into the head (or internal circuitry) will provide few clues about its behavior. To understand it, we must look at its ongoing interactions with its environment.

Thus, in addition to looking at things from the *bottom up* (simple to complex), Barrett's approach also looks at things from the *outside in*, emphasizing the important role of the environment in shaping and maintaining complex behavior. Barrett's position on cognition is summed up well here: "In a distributed or extended approach to cognition, then, actions in the world are not merely indicators of internal cognitive acts, but are cognitive acts in themselves" (p. 217).

Barrett's strategy is to take examples of complex behavior, seemingly requiring complex internal mechanisms, and to show how in fact it can be explained in simpler terms. She describes, in fascinating detail, the behavior of *Portia*, a type of salticid spider (jumping spider), an expert hunter that follows an elaborate coordinated sequence of behavior to capture prey (other spiders). Prior to movement, the *Portia* systematically scans the environment, its visual system attuned to certain geometric regularities in the environment. The behavior appears to reflect thoughtful planning—and indeed, this is the common explanation—but Barrett shows that it actually reflects sensitivity to local events and feedback (i.e., rules of thumb). The scanning that precedes the hunt is more properly *perception* than *planning*.

But even here, perception is not to be understood in the traditional sense, as internal screening mechanisms, but as actions in the world:

> Perception is not "in" us and it doesn't happen "to" us; it is something in which we actively participate…whatever "cognition" is taking place, it is taking place not solely in the animal's head, but out in the world: action in the world can, justifiably, be considered to be just as "cognitive" as things that happen inside an animal's head. (p. 108)

Ecological and Embodied

Such passages may have a familiar ring to those acquainted with J. J. Gibson's ecological approach to perception and cognition, and indeed, Barrett pays an intellectual debt to Gibson in several places in the book. (The conceptual affinities between Gibson and Skinner have been noted previously, e.g., Costall, 1984). A key concept for Gibson is that of an *affordance*—a stimulus event that *affords* action. This definition implies an inextricable connection between environment and behavior; environmental events are meaningful only to the extent that they permit action.

Gibson's views are contrasted with the orthodox representational views—i.e., that the world is an illusion that can only be known indirectly via interpretation. The representation is the internal surrogate of the environment. But why, Barrett asks, should we appeal to internal surrogates of the world when we have direct access to the world itself? The problems with these types of mentalistic explanations are both logical and biological. Logically, this approach simply begs the question as to who/what will react to the representation. It raises the specter of a homunculus, or little person in the head, who responds to the representation. But this then requires another homunculus to respond to the representation in the head of the earlier homunculus, and so on, ad infinitum. In addressing the limitations of the representational view of perception, Skinner (1963) once remarked:

> It is most convenient for both organism and psychophysiologist, if the external world is never copied – if the world we know is simply the world around us. The same may be said of theories according to which the brain interprets signals sent to it and in some sense reconstructs external stimuli. If the real world is, indeed, scrambled in transmission but later reconstructed in the brain, we must then start all over again and explain how the organism sees the reconstruction. (p. 954)

And biologically, such representational views are badly out of step with evolutionary thinking. It would be incredibly costly in terms of internal machinery to carry complexity around in the head. It would be far more efficient to "offload" to the environment, as Barrett notes:

> If there is information freely available in the environment, why would natural selection go to the trouble of building in internal mechanisms that do

> exactly the same job?" …[T]his isn't quite the same as saying that no internal activity takes place. Instead, it's an argument for giving the external environment as much attention as the inside of an animal's head when we are investigating their cognitive capacities. (pp. 110–111)

Forcing complexity into the head places enormous cognitive burdens on the brain. It is much simpler and more evolutionarily sound to assume that complexity lies in the environment.

According to Barrett, perception and cognition are *embodied* actions in relation to the world, not static representations of the world. She provides some intriguing examples of how brain activities, in rats and humans, differ depending on whether an explicit motor act is involved. In one experiment, for instance, people wearing distorted lenses are asked to throw darts at a dartboard. With enough experience, the people adapt to the changes in their perceptual world and can eventually make accurate throws—but *only if* the same movements are involved. If a different movement pattern (say, an underhand toss) is substituted for the original movement (say, an overhand toss), the experience-based improvements are lost. In other words, the whole of the perceptual world is not reorganized—as the orthodox representational view would imply—only the parts involving the specific actions.

Perceptual systems, therefore, do not create "replicas of the world within the head" (p. 155), but rather are externally situated and embodied—they depend on the actions of the rest of the body (including, but not limited to, the brain). This fits well with Gibson's ecological view that perceptual systems are geared for action.

Dynamic and Distributed

Barrett also discusses the work of Rodney Brooks and his action-oriented robots to illustrate the power of a nonrepresentational bottom-up view of cognition as action. Brooks is well known for challenging the orthodox view of machine, or artificial, intelligence as a top-down process with central controllers (analogous to a brain). While these types of systems are well suited to logic-based tasks formulated as a set of procedural rules, such as playing chess, they are seriously deficient when it comes to basic adaptive functioning, such as moving around in the world and making simple discriminations. Rather than starting with complex rule-based cognitive skills, Brooks (inspired by insects) started with simple behavior and layered on additional complexity acquired through experience. That is, he built the robots to learn via their interactions with the environment. In these systems, complexity arises from the simple interactions and feedback of the component parts; cognition is a product not of internal mechanisms but of the whole organism interacting with its environment: "Our understanding of "higher" cognition…has to be grounded in a firm understanding of the ways in which perception and action mechanisms lead to adaptive behavior in dynamic environments" (pp. 158–159).

Barrett notes interesting parallels between these types of bottom-up and outside-in systems to Vygotsky's work on cognitive development in children: "…a child's mental processes are not the source and cause of her behavior in the world; rather a child's behavior in the world is the source and cause of what eventually ends up in her head: the exact reverse of what most modern psychology would have us think" (p. 37).

Along with Vygotsky, Piaget also recognized the primacy of action in the world. What ends up in the head begins in the world. As Barrett puts it:

> Development isn't an "inevitable march toward maturity" but something more fluid: a process that unfolds over time, showing patterns of dynamic stability that evolve and dissolve, as the result of varying interplay of multiple internal and external influences. (p. 181)

She discusses how various developmental patterns, including the emergence of cognitive skills, are best characterized without the *concept of a concept*—at least not of the static, representational variety. If concepts are to be retained in an explanatory account of development, they are more usefully viewed as residing "in the system as a whole—the baby coupled to the world—and not in the baby's head as some kind of symbolic, static representation" (p. 185).

The Embodied Brain

But what about the brain? Do distributed, environment-based approaches discount or diminish the importance of the brain in adaptive functioning? Are they anti-

brain? No, Barrett argues; they simply provide a new way to think about the brain—as a *participant* rather than as an *agent*. The brain is part of the body and cannot exist apart from it or its environment.

> [It] is important to restore a balance…and to see brains as parts of bodies that together make up a whole organism, whose main aim is to produce behavior appropriate to its circumstances. A brain is just one of many resources available to an animal to achieve this, along with the other physical properties of its body and its environment, and discovering how all these aspects fit together in the service of an animal's ultimate goals is an immensely exciting challenge. (pp. 171–172)

Barrett illustrates the dynamic coupling of behavior-brain-environment with some work by Freeman on the olfactory system of rabbits. The nerve cell assembly (NCA) is a system in the olfactory bulb that is activated by stimulation of any of its parts. Signals are amplified over the whole of the NCA, which serves as a mechanism that enables a cascade of activation across the entire bulb. The configuration of the bulb is constantly shifting in ways "that reflect the sum total of the rabbit's experiences with a particular stimulus, the contexts in which these occurred, and the significance they hold for the rabbit, and they also bear the signature of the rabbit's experience with other odor-reward pairings" (p. 141). The example helps make the excellent point that odors are not unitary things represented in the brain but rather are inseparable from past experience and current context.

Perhaps one could salvage the idea of a representation by pointing to the activation patterns of the NCA. But the patterns here are distributed and interactive, not static and unitary. As such, they stretch the concept of representation-as-surrogate beyond its usual meaning. According to Barrett, the orthodox representational view is woefully inadequate to capture the dynamic complexities of the brain in continual interaction with the environment:

> We are doomed never to gain a satisfactory insight into how other animals act and understand the world if we persist with such a view, because intelligent, flexible behavior is never exclusively the product of cognitive processes occurring in the brain. *There is no such thing as a naked brain*. (p. 151; emphasis added)

Removing Ourselves

Barrett discusses some of the philosophical problems with brain-biased thinking, such as the *mereological fallacy*—attributing to parts functions properly of the whole (Bennett & Hacker 2003; see also Schaal, 2005). She calls this "anthropomorphizing the brain" (p. 103) and is part of the more general human tendency to project our own likeness onto the rest of nature.

While such anthropomorphic tendencies are relatively harmless in everyday casual discourse, they are deeply problematic in scientific accounts, promoting "the idea that other organisms are interesting only to the degree that their abilities and capacities match our own" (p. 4). To illustrate some of the perils of anthropomorphism, Barrett uses several examples, including one claiming to show a human-like brain in a flatworm. In reality, this particular variety of flatworm has a constellation of cells, called mushroom bodies, also found in the mammalian cortex. But rather than emphasizing the shared precursor of vertebrate and invertebrate tissue hundreds of millions of years ago, the anthropomorphic narrative projects the human onto the worm, suggesting an inevitable march to human braininess. The worm has no use for a brain, human-like or otherwise, and has flourished for eons without one; brains are only required by our human-centered accounts of nature.

Not content to merely point out the flaws in anthropomorphic thinking, Barrett digs further into the reasons why this faulty way of thinking is so deeply entrenched in humans. Such tendencies to attribute human motives to other agents seem to extend even beyond animals to nonbiological human-constructed entities. Classic works by Heider and Simmel (1944) and by Michotte (1962) show that people attribute human agency (and even personality characteristics) to geometric figures moving around a screen.

Barrett suggests that such deep-seated anthropomorphic tendencies have roots in our evolution as social primates, a by-product of other characteristics that have been selected for; the ability to read and interpret the actions, tendencies, and motives of others has had important survival outcomes in primate evolution. Thus, problematic intellectual tendencies, such as anthropomorphism, can themselves be explained in evolutionary terms. But even here, the abilities do not reside *in the head* but rather in the extended interactions with social environments in which they operate. Corresponding brain structures have also evolved, of course, but the

causality is bidirectional. In other words, the structures are not innate but rather develop via experience. They are primed via evolution but only come to fruition through specific experiences in social environments. This, too, makes adaptive sense, as fully formed abilities (and associated brain structures) would be too clunky and rigid for evolution to work upon.

Leashes, Long and Short

In place of anthropomorphism, Barrett advocates an animal-centered perspective that uses the latest scientific findings to understand how others sense, perceive, and act in the world. An important concept here is that of the *umwelt*—the idea that each animal inhabits its own unique environment, and to understand how that animal perceives, remembers, and acts, one needs detailed information about its environment and its body (including, but not limited to, its brain).

Useful sources of information come from observing animals in their natural habitats. Classic experiments on instinctive behavior provide important insights into how an animal sees the world—its response predispositions, the stimuli that evoke them, the time frame during which the stimuli must be presented, and so on. Take imprinting, for example, the prototypical instinctive behavior, in which a newborn animal will follow the first moving object it encounters. Barrett calls these *short-leash* mechanisms because they are under fairly rigid control of narrow ranges of stimuli. Such short-leash mechanisms work fine, so long as the environments are relatively stable. The first moving object is normally the animal's mother, and so, in the large majority of cases, following the mother makes good adaptive sense. Under these conditions, short-leash mechanisms are sufficient to generate adaptive behavior most of the time.

Short-leash mechanisms run into trouble, however, when the environment changes. If a moving stimulus other than the mother is present during a sensitive period in the early hours of life, that stimulus will become the imprinted stimulus. This was shown in a classic study by Lorenz, in which ducklings imprinted on Lorenz himself and followed him around as if he were their mother. Thus, even seemingly simple instincts are not hardwired responses triggered by a specific stimulus but rather depend on experience.

Experience can also modify the form of the response. Though not discussed by Barrett, laboratory experiments by Peterson (1960) have shown that it is not a specific response (following) that is inherited but rather a susceptibility to reinforcement by proximity to a moving object. Newly hatched ducklings were trained to peck a key, the only consequence of which was to maintain visual access to a moving object to which they had been imprinted. Thus, while following after its mother is the normal way to maintain close proximity, if the environment changes, responses other than strict following may develop. This, too, makes evolutionary sense. Rather than transmit a specific response across generations, it is far simpler for evolution to create a capacity for reinforcement functions that, when combined with experience, produce the adaptive behavior.

This works fine in stable environments. In less stable environments, however, behavior must adapt to changing contingencies, placing a greater premium on flexible, or *long-leash*, mechanisms. A monkey maintaining its place in a social hierarchy, or a bird remembering the location of food buried months earlier, requires more flexible types of control. Such long-leash mechanisms lie on top of and interact with short-leash mechanisms. A good example is provided by stick-tool use in woodpecker finches. Young birds in a particular ecology engage in precurrent behavior of manipulating sticks—mainly poking and probing under short-leash control. If the birds then subsequently receive experience using the sticks to extract prey (insect larvae) during sensitive periods, full-blown functional tool use develops. Thus, a flexible and highly adaptive response (tool use) under long-leash control rests upon short-leash mechanisms. Flexible behavior, however, implies a flexible environment:

> The broader perspective we have explored here allows us to see that flexibility and intelligence are properties not of brains alone, but of the embodied, environmentally situated, fully integrated complex that we know more familiarly as an "animal." (p. 222)

Extended Mind

Extending the analysis to human behavior, long-leash mechanisms include those surrounding verbal skills. As Barrett notes:

> Language gives human brains a new way of dealing with the world. We haven't been "reprogrammed"

> by language; rather, we use it as we use a pair of scissors. It provides us with an extra loop of control over our behavior. (p. 195)

Barrett thus takes a pragmatic approach to language, broadly consistent with the functional analysis of verbal behavior of Skinner (1957). By this view, language does not reflect our thoughts but might be seen as the thoughts themselves.

> So, when we write an essay, we are not having thoughts and then writing them down. Instead, the act of writing is itself an act of thinking, because it's a way of using language in a fashion that allows us to precisely order our thoughts and convey what we mean. The thought is produced by and through the act of writing. Without writing, we couldn't have these kinds of thoughts. (pp. 194–195)

This runs counter to traditional representational theories of language, according to which different modes of behavior (e.g., writing and speaking) are merely different ways to express an underlying idea; they are different ways of representing the world. According to Barrett, however, thought—or better, *thinking*—cannot be separated from the environment and sensorimotor systems through which it occurs; it is always situated and embodied.

> This emphasizes that how animals act is at least as important as how they think. Indeed, in this approach, acting simply is a form of thinking, and we don't need to posit any kind of linear internal, representational input-processing-output procedures to account for the organized patterns of behavior that organisms display. (pp. 142–143)

Barrett introduces the notion of the *extended mind*, as developed by Clark and Chalmers, according to which the *world* is as important as the *head* in the constitution of a cognitive process:

> …if we think of cognition as an active process, and "mind" as something animals do rather than something they "have," then questions about whether "minds" are things inside the head, or things that can exist outside them, don't really make much sense. The metaphor of "containment" that we are using to think about these things – that a mind is a thing inside a person and distinct from the outside world – begins to break down. (p. 199)

By this view, *mind* is to be understood not in the traditional sense of an internal mechanism but as a distributed/extended pattern of interaction with the environment. This provides a fresh new way of thinking about many traditional phenomena in psychology. Take memory, for example.

> …memory is not a "thing" that an animal either does or doesn't have inside its head, but a property of the whole animal-environment nexus; or, to put it another way, it is the means by which we can coordinate our behavior in ways that make it similar to our past experiences (p. 214)

This view of mind as extended interaction with the world blurs the distinction between the internal and external: "[T]he boundaries of the body are… "negotiable" …because organisms are always mutually entangled with their environments and do not stand apart from them as some kind of hermetically sealed, disembodied cognizers" (p. 200). So, too, in a passage well known to many behavior analysts, Skinner (1963) asserted: "The skin is not that important as a boundary. Private and public events have the same kinds of physical dimensions" (p. 953).

Skinner's stance on private events is one of the distinctive characteristics of radical behaviorism, departing from other forms of behaviorism, many of which rejected private events on the grounds that they were mental and therefore beyond the scope of science (Moore, 1985). Including such events within the analysis is one reason radical behaviorism has been able to remain vital while most other behaviorisms have died off. Yet, despite Skinner's sophisticated conceptual analysis of privacy, there has been little empirical work on the topic of privacy arising from the Skinnerian tradition. The literatures and ideas Barrett touches on here are well worth knowing about and may help spark productive collaborative work on privacy.

To take just one example, Barrett discusses work by Maravita and colleagues who mapped neural activity in the intraparietal cortex of monkeys in relation to a tool-use task. There are neurons in this brain region that respond both to visual and somatosensory stimulation, enabling one to map the visual and somatosensory receptive fields that comprise an important part of the animal's body schema (i.e., boundaries between the body and the environment). Following only brief experience using a rake-tool to pull food within

reach, the receptive fields reorganized to include the rake and objects stimulated by the rake, suggesting that the tool had become an integrated part of the body. Importantly, the tools must actually *do* something—they must be instrumental in achieving some end; the rake does not become integrated in the body schema when it is held passively. As Barrett says, "if we accept that the skin…isn't that important as a boundary, we will begin to find it more natural to think in terms of the mutuality between animal and environment" (p. 160).

Conclusions

Barrett's book contains many bold ideas, expressed in a lively and engaging style; with nice touches of humor, it is both thought provoking and entertaining. Her relational, environment-based, action-oriented perspective is deeply compatible with behavior analysis, and I suspect many behavior analysts will be nodding in agreement with many of the thoughtful and well-developed arguments put forth in the book. At the same time, however, the wide-ranging content covered in the book—including robotics and artificial intelligence, developmental systems, complexity theory, evolutionary biology, perceptual and motor learning, and comparative psychology, to name a few—expands the behavioral perspective in exciting new directions.

Reading Barrett's book is like meeting a long-lost relative, perhaps one who has lived abroad for some period of time, who brings us into touch with new ideas and points of view, but shares a common family history and perspective. Constructively engaging Barrett and others of her ilk from the rapidly growing areas of situated and embodied cognition (see also Chemero, 2011; Noë, 2009; Wilson, 2002; Wilson & Golonka, 2013) will promote constructive and mutually beneficial interdisciplinary dialogue. Such efforts will be most successful if approached, as with the distant relative with intriguing tales of unfamiliar domains, with humility and openness to new concepts and ideas beyond our usual intellectual borders.

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