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The Essential Elements of an Evolutionary Theory of Perception

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Abstract

Traditional theories of perception developed for centuries before Darwin conceived his theory of evolution by means of natural selection. While many areas of psychological theory and research now have mainstream approaches strongly influenced by evolutionary thinking, mainstream perceptual theory remains close to its pre-Darwinian roots. This paper draws on insights from Ecological Psychology, especially as represented in Gibson’s *The Senses Considered as Perceptual Systems*, to identify four elements that any future evolutionary approach to perception should be expected to include: 1) an ecological analysis of ambient energy; 2) a comparative understanding of the perceptual abilities of different species; 3) an dynamic understanding of organism-environment interaction as essential for perception; 4) an understanding of perceptual attunement based on the concept of affordances. Each of these elements serves an essential theoretical role, while also pointing towards lines of research where much work remains to be done. The presence of these elements in ecological psychology explains, in part, the affinity between ecological psychology and other more evolutionarily-grounded approaches to psychology, including the emerging fields of enactivism and embodied cognition.

An Evolutionary Theory of Perception: Essential Elements

 There have been many “theories of perception,” so may that it is easy to lose track of what a theory of p*erception* is trying to explain. This difficulty is exists, in a large part, because it is unclear what perception is in contrast to. It is tempting to say that a theory of perception should explain “lived experience” or “the phenomenal world,” but that won't do, if perception is supposed to contrast with hallucination, imagination, and other such experiences. With such contrasts in mind: Perception is happening when a father tries to catch a ball thrown by his son, but not what is happening when the father stands alone on his lawn, imagining and acting-out a game of catch with his deceased parent. That distinction holds even if the father’s movements, taken on their own, are very similarly in both cases. Similarly, under conditions where observers might say that a patient in a mental ward is hallucinating a tiger, they would probably not, if they were speaking carefully, want to say that the patient “sees a tiger” in the empty room. The observers would, at best, say the patient is “acting *as if* he sees a tiger.” This is not a trivial exercise; it is imperative to try to start with a clear description of the thing-to-be-explained by a theory, so that, at the least, it is possible to recognize the types of explanations that will have a chance at being satisfactory. If a group of psychologists were to examine the conditions under which people talk about perceiving things – about seeing, hearing, smelling, feeling, etc. – those psychologists would, I believe, come to an agreement on the thing that needs to be explained.

 People talk about seeing, hearing, etc., under conditions where our acting towards the world is assisted (or, at the least, is believed to be assisted) by the presence of certain types of energy. For example, “seeing” is what is happening when we interact with our world better by virtue of its being illuminated; “smelling” is what is happening when we interact with our world better by virtue of there being chemicals suspended in the air around us. That is, when we are aided by the presence of light, we call it “seeing”; when aided by the presence of chemicals in the air, we call it “smelling”; when aided by vibrations in the air, we call it “hearing”; etc. Might a theory of perception need to explain more than that? Perhaps. But the concern here is with identifying essential elements of a theory of perception, and so secondary and tertiary concerns can be put aside. It is foundational that, at a minimum, *any theory of perception must explain* *how our ability to act is improved by our living a world filled with ambient energies*.

 What more would be needed to begin talking of an *evolutionary* theory of perception? Such a theory would be expected to explain the existence of perception (which was just described), through the lens of Darwin and Wallace's theory of evolution by means of natural selection. Darwin's theory itself attempts to explain the distribution of traits among various kinds of living creatures, by reference to the past worlds in which past generations found themselves. Well-formed Darwinian stories explain where a form started (e.g. a cat with uniform orange coat), then add descriptions of the ancestral world and the ancestral organisms’ place in that world (e.g., the grassy planes and a tendency to hunt vigilant gazelle); and from that, the evolutionary stories hypothesize that the appearance of certain traits assisted actual-ancestors in consistently out reproducing potential-ancestors who lacked those certain traits (e.g., the rare cat born with a striped coat fit the grassy environment better – was thereby able to sneak closer to the gazelle before alerting them – and ultimately produced more offspring than peers who had uniform orange coats). So long as the traits in questions were, to some degree, heritable, such stories explain past changes in the distribution of organisms with and without such traits (e.g., why some currently-existing species of wild cats have stripes, while others do not). This whole apparatus is crucial to keep in mind, because it emphasizes that an evolutionary explanation should have, as essential elements, a) a starting point before the adaptation in question existed, b) a world in which such organisms found themselves, and c) a mechanism by which said adaptation assisted the organism in some way… ultimately assisting them in the struggle to reproduce (Conway & Schaller, 2002, Coss & Charles, 2004).

 Most approaches to psychology and behavioral biology do not give consideration to these elements in relation to organisms’ perceptual adaptations. Most approaches take perception for granted. They investigate the organism’s response to perceived objects and events, but show no interest in explaining *how* the organism perceives. The typical form of this oversight will be familiar to readers:

Beach speaks for comparative psychologists [animal behavior researchers] when he says, in describing how birds feed their offspring, “young birds exhibit a gaping response which stimulates the parent to place food in the nestling’s mouth”. He takes it for granted that light rays can specify the event called gaping and refuses to worry about it further. (Gibson, 1960, p. 699)

The same criticism could be leveled against many approaches to psychology, which typically offer potential solutions to many types of psychological questions, including many questions tangentially related to perception, but entirely pass over the issue of perception itself. To take a classic example: A psychoanalyst might offer an explanation for why a young child panics upon seeing a horse, and in so doing “takes for granted” that light rays can specify horses. Similarly, behavioral researchers in psychology often dismiss perception as uninteresting, with the explanation that it is “merely” the first part of behaving (e.g., Skinner, 1989, p. 14). “Evolutionary Psychology,” in its currently popular vein, also falls into this category: Contributors to the field are extremely interested in the survival-utility of what people think (or how they behave) under particular conditions, but are not much interested in the more basic question of how people *are able* to respond to their circumstances.[[1]](#footnote-1)

Modern cognitive psychologists have the opposite dilemma: There is a tremendous amount of work on perception, but psychologists tend to consider questions about perception and behavior as conceptually independent, preferring to treat perception as the first part in the path to some sort of higher mental functioning.[[2]](#footnote-2) These cognitive approaches have their roots in attempts to answer dualistic challenges about how physical things can be known by mental things: how objects “enter” awareness; how the nerve signals “re-present” objects to “the mind”; how memories “combine” with deficient sensory stimulation to “create” a mental world; etc. There is little to no concern for understanding adaptation, little to no consideration about the structure of the environment,[[3]](#footnote-3) and the more “perception” is removed from “sensation”, the closer it gets to imagination. The overall lack of evolutionary logic in traditional theories of perception is not totally surprising, as theories of perception developed for thousands of years before any true evolutionary theories existed. Costall (1981) has argued that when the terminology used to describe perception is limited to that of traditional theories of perception – theories whose language originated specifically to describe an ethereal, non-functional, non-physiological, mental process – then conceptual development cannot help but be stunted. (See also Wagman & Miller, 2003.) Thus classic philosophical debates are perpetuated in current theory, as theorists and researchers try to determine how organisms form an internal representation of the world out of deficient stimulation. The millennia-old question of how we come to “know” the world, when phrased this way, leads to nature-nurture debates and (despite physiological referents) to entrenched mind-body dualism.

As a result of the above considerations, little work has been done towards a proper evolutionary theory of perception. That said, there is some work. There is enough, I believe, to lay out some basic elements that should be expected of any future attempts at an evolutionary theory of perception, and without which any future theory should be deemed insufficient. To illustrate these elements, I will excerpt aspects of James J. Gibson's “Ecological Psychology,” particularly as represented by his 1966 book *The Senses Considered As Perceptual Systems*. Not all details of Gibson's larger system need to be incorporated into future theories, but several of the larger conceptual insights are necessary and foundational. Indeed, many proponents of emerging approaches are incorporating these elements into their systems, including advocates for more radical statements of the embodied cognition movement, the enactivist movement, proponents of perceptual control systems approaches, and other (see Charles, 2013). These essential element of an evolutionary theory of perception include: 1) an ecological analysis of ambient energy, and the specification therein; 2) a comparative understanding of the perceptual abilities of different species; 3) an interactive understanding of organism-environment dynamics as essential for perception; 4) an understanding of perceptual attunement based on the concept of affordances.

**Element 1: Ambient Energy and Specification**

Question: “If vision was gradually evolved, as we know it was, the question is, why?”

Answer: “Visual systems presumably developed in order to take advantage of the information in ambient light.” (Gibson, 1966, p. 155 and p. 184)

Gibson's “Ecological” approach is so named because he first proposed the label “Ecological Optics” for the study of patterns in ambient light (Gibson, 1961). When we think about seeing, we tend to think about the light that happens to enter the eye, wherever the eye-in-question happens to be at a given moment. But light can only enter the eye because that eye is at a point in the environment which would be full of light, whether an eye happened to be there or not. The light that fills the environment, the “ambient light,” is the object of study in ecological optics. It is part of our ecology, and is structured based on the properties of the objects and events that surround us.

Some of the structure in ambient light is revealed from any static point, but movement allows an organism to be exposed to additional structure by sampling optic arrays that are spread through the environment, i.e., movement reveals the structured ways in which visible light transforms between arrays.[[4]](#footnote-4) Because the patterns in ambient light are the result of the objects and events in the environment, *some* of the patterns will be *specific to* properties of those objects and events; some patterns will be “unequivocally related to a property of the object by virtue of physical laws” (Gibson, 1966, p. 187). The ambient light also includes many patterns that might serve as “cues,” in the traditional sense of being imperfect-correlates with properties of interest; such cue status would be due to happenstance statistical regularities in the current environment, rather than natural laws.[[5]](#footnote-5) The relation between cues and specification will be discussed further below. The key point here is to acknowledge that both types of patterns exist in the organism's environment.

The external orientation of the ecological approach, starting with an analysis of the world outside the organism, is key: The existence of such structure in the environment – in light, vibrations, suspended chemicals, and other forms of energy – is the ecological property that organisms evolved perception to take advantage of.[[6]](#footnote-6)

**The Key Point**

*Any evolutionary approach to perception must have, as an essential element, something equivalent to Gibson's ecological optics.[[7]](#footnote-7)* There must be a study of the patterns of energy that surround us, and which are available, in the environment, to inform us about the properties of objects and events. To return to Beach’s quote: We must wonder what it is, in the light, that specifies the crucial properties of the gapping chick, to which the mother bird responds by regurgitating food. Similarly, if we want to say that humans have an evolved preference for symmetrical faces (as has been frequently proposed), and we are willing to admit that it is not often that we get to stare for prolonged periods at a stranger's face, perfectly straight on, then we must wonder how something like “the symmetry of an face” can be specified in the light available to someone moving around an object at many angles.

*This opens the opportunity for specific research programs not commonly found in perceptual research.* A healthy field of evolutionary research into perception would value research into the energy ecology. Researchers would, for example, look outside the visual system itself, to identify evolutionarily meaningful patterns of energy which animals would be expected to discriminate. Just as there are debates in behavioral ecology about the aspects of the environment to which different behaviors are adapted, perceptual researchers could create a thriving field debating which energy patterns organisms' perceptual systems have adapted to. Though ecological psychologists and members of allied fields, such as proponents of Perceptual Control Theory (Marken & Mansell, 2013), have scored some significant victories in this regard, the majority of the work needed to form this field remains to be done.

**Other Points to Consider**

It is worth noting related aspects of the ecological approach that may be of interest to evolutionary theorists, but need not be essential to future theories: Ecological psychologists are particularly interested in the “higher-order invariants” that exist within the transformations of ambient energy. We might think of higher-order invariants as mathematical constants that underlie transformations, in the same way that a constant rate of acceleration can underlie changes in speed. Whereas it was stated above that a given *pattern of energy* can specify a particular property of the environment, some ecological psychologists would prefer to say that the property of interest is specified by the *higher-order invariant* underlying the particular pattern. This is partially a linguistic point. It is often more convenient to talk about an organism’s sensitivity to an optic invariant, than it is to talk about an organism’s sensitivity to the pattern which the invariant underlies. However, it is also a substantive point, as higher-order invariants provide a natural way of classifying patterns of energy, and are therefore more likely to specify relevant environmental properties than are particular patterns as such. For historic reasons, Gibson was particularly interested in the notion of specification, and he used the term “information” to refer to those higher-order invariants that specify properties of the environment.[[8]](#footnote-8) The possibility of specificity has important implications for many long-standing philosophical debates regarding perception, including debates about the possibility for “direct perception.” However, while any evolutionary theory of psychology will need an equivalent to Gibson’s ecological optics, it is not essential that they take a side on the “direct perception” debates.

**Element 2: A Comparative Understanding of Perception**

It is clear that [traditional perceptual theory’s] answers are anthropomorphic. The objective study of animal behavior is a better guide than introspection to the utility of vision... one surveys the whole realm of behavior that is controlled by light, from the phototropisms of the simplest creatures to the hunting behavior of the octopus, the dragonfly, and the hawk... (Gibson, 1966, p. 156)

Evolutionary theory is not about how any particular ability of any particular animal got to be the way it is; evolutionary theory is about how different species of organisms, occupying different niches, came to have their characteristic properties. Thus an evolutionary theory of perception must attend to the perceptual abilities of species other than humans. Even a theory focused on humans – if it wished to lay any claim to being an evolutionary approach – would need to provide some explanation for the differences between ourselves and our nearest relatives, and for the similarities we share with organisms that inhabit niches similar to our own.

Sticking with vision, for example, even traits such as foveated retinas, forward facing eyes, and similar aspects of the human eye-head-neuro-muscular “perceptual system” should be viewed as adaptations to broad features of the ecological optics unique to *some* niches, and understood in relation to the behavior of *particular* species*.* The quote that follows is long, but it illustrates the layered depth of comparative thinking that an evolutionary theory of perception should be expected to display. It combines insights about the cyclic connection between perception and behavior within the adaptive process (co-evolution of perceptual and behavioral abilities), with insights about the variety of environments that organisms find themselves in and the multiple potential solutions to the perceptual challenges faced in those environments:

As eyes became more efficient in the course of evolution, providing better adaptation to the special environment in which they operated, the nervous equipment behind the eyes had to become more elaborate too. The system as a whole became more acute. But there were alternative ways of using this discriminative capacity....

Certain directions-from-here, in which things need to be seen, are more important than other directions, depending on the animal's way of life. The general direction *ahead* is often more significant than the direction *behind*, as already noted. The direction *above* may be more significant for some species than the direction *below,* but the significance can be reversed for other species.... Evenly dispersed panoramic vision in all directions is therefore wasteful, and some animals adapted this fact by concentrating the resource of each eye, that is, by a tendency towards foveation.

But note that the full development of frontal eyes with foveas must be accompanied by the development of the ability to *look* --- That is, to explore the optic array by scanning it. If panoramic vision is restricted, the ability to look around must be substituted. The parts of the array must be fixated in succession.... The exploratory fixation can be carried out by the eyes alone in vertebrates with freely mobile eyes; otherwise they must be performed with the head, as happens in many birds, or with the whole body, as happens in many anthropods....

The evolution of visual attention began early, but it did not take the same course in all species and it did not end up with the same kind of visual attention that we primates have developed. Some fish have centers of acute vision in each eye pointing outward to each side and thus can “look” with either eye or, probably, with both eyes at the same time. Some birds have two foveas in each eye, one for fixation to the side and another for fixation forward. Other birds have a strip fovea... still other expedients are possible, such as the “four-eyed fish” who can see both above and below the surface of the water.... (Gibson, 1966, p. 174-176, see also Walls, 1942).

Good comparative work can also lead to developmental hypotheses, as exemplified by Eleanor Gibson's work on the visual cliff (e.g., E. Gibson & Walk, 1960). Most people have a passing familiarity with studies showing that most young infants, when presented with a steep drop off (in a lab setting, where a glass walkway will protect them), will not crawl over a visual cliff. The original experiments involved many alterations of the visual scene that infants would see when looking over the cliff, attempting to determine what patterns infants were responding to. More noteworthy, in this context, experimenters also examined several other species, including animals reared under unusual conditions:

On the visual cliff we have observed the behavior of chicks, turtles, rats, lambs, kids [goats], pigs, kittens and dogs. These animals showed various reactions, each of which proved to be characteristic of their species. In each case the reaction is plainly related to the role of vision in the survival of the species, and the varied patterns of behavior suggest something about the role of vision in evolution. (p. 64)

Those studies found that young goats, sheep, and chicks will avoid visual cliffs from their first day of life, with goats and lambs responding with a stereotypical rigid freezing. Young turtles, on the other hand, did not behaviorally discriminate based on visible depth. Most interesting were the experiments done on dark-reared and light-reared rats and kittens. Dark rearing involved keeping the animals in total darkness for several months. This would be a very unusual situation for a cat, but could certainly be an evolutionarily relevant experience for a rat. Indeed, dark-reared cats showed no discrimination of the visual cliff, and wandered over it willy-nilly, while dark-reared rats, experiencing optical patterns for the first time in their lives, avoided the visual cliff just as well as their light-reared relatives.

**Key Point**

*Any evolutionary approach to perception must have, as an essential element, something equivalent to Gibson's comparative approach.* While the broad categories of animals referenced above are not as detailed as many evolutionary hypotheses commonly tested by biologists, they at least meet the criterion of testing for differences between species that would be predicted based upon the species' different niches.

When contrasted with much of the work that currently goes under the label “evolutionary psychology”, the requirement for comparative study might seem odd. Why is it not sufficient that researchers simply make a prediction based on a theorized “environment of evolutionary adaptiveness”, such as the Pleistocene Savannah, and then show that modern humans behave in the way expected? Certainly researchers can do that, and such work has led to many empirical confirmations, but that doesn’t really test the *evolutionary* part of the hypothesis. It could be that the behaviors in questions are common to any primate group, or any social species, or even to large swaths of the vertebrate kingdom. That is, showing that humans have a certain trait is *not* evidence that the trait in question is an adaptation, and certainly not evidence that humans uniquely evolved the trait during a particular historic epoch. The best way to test hypotheses regarding behavioral evolution (that has no obvious anatomical underpinning), is to engage in the comparative study of existing species: To entirely cut off comparative work is to ensure you are not testing evolutionary hypotheses.

*This opens the opportunity for specific research programs not commonly found in perceptual research.* Evolutionary hypotheses about perception represent an entire class of hypotheses not normally considered by researchers, regarding differences that should be seen between species. In addition, it is worth noting that most research into perception is focused on humans, in laboratories. Much less research has been done on human perceptual abilities in natural or naturalistic settings, or on the perceptual abilities of animals in more natural settings. Research on the behavior of non-human animals lends itself to certain types of studies that are much harder to do with humans, such as studies of the behaviors of perception, i.e., the movements that animals engage in to enhance their ability to perceive the world. (See also Flynn & Stoffregen, 1998, and Adolph & Berger, 2015.) While ecological psychology and its allied disciplines have seen some minor successes in these regards, they have only scratched the surface.

**Element 3: Organism-Environment Dynamics Inherent to Perception**

The process of extracting invariants from ambient light is not [fully] understood… but it is so radically different from a process of constructing an internal model of the world that it would put the study of perception on an entirely new footing if we accepted the possibility. (Gibson, 1973, p. 396)

The recognition that animals evolved perceptual abilities *because* doing so allowed them to take advantage of the structure available in ambient energy arrays, forces a dynamic (not static) foundation for perceptual processes. This is because the detection of such structure requires moving through the world in particular ways, and may even require particular modes of interaction with the relevant objects and events. Rejected is the idea that perception is best studied when movement can be eliminated – e.g., a still person, looking at a still image – and in its place is recognition that movement and interaction are inherent parts of the most basic perceptual processes. Thus, beyond the anatomical adaptations discussed above, organisms would be expected to have *behavioral* adaptations that enhance their ability to detect relevant properties of their world. At the least, it would be acknowledged that all anatomical adaptations for perception only make evolutionary sense in the context of an organism that goes about perceptual activity in particular ways; e.g., the dual foveas of many birds only make sense given that those birds fly in ways that make such foveas useful. The same principle applies to other perceptual systems, but we know even less about the behavioral adaptations relevant in such cases. The manner in which different animals move when smelling, listening, etc., will allow them to uncover different types of patterns in the relevant energy arrays.

Returning to vision: The most obvious example of movement-for-seeing is probably the way in which the relative distance of objects is specified by motion parallax. This is the phenomenon by which, when you move, bits of the ground near you enter and exit the resulting optic flow quite rapidly, while far away objects stay much more constant in appearance. (Having two eyes, with largely overlapping visual fields, allows a quick approximation of this effect by blinking from one eye to the other.) The perception of the relative distance of objects by means of motion parallax might require a person to bob his or her head; in contrast, a lobster could actively move a single eye stalk, while a frog would need to move its whole body. Meanwhile, a predatory fish that likes to ambush prey might be able to sample the same patterns simply by letting its camouflaged body bob up and down in the natural currents of the water.

The prior examples show that action is typically needed to detect energy patterns, even when those patterns exist independent of an animal’s actions. Beyond that, however, many of patterns that organisms might benefit from detecting are actively created by the organism’s interactions with the environment. For example, there is optic and vibratory specification of hardness that is created when objects collide, and one could learn much about the hardness of surfaces by dropping things on them and observing the result. Seagulls, for example, are quite good at quickly limiting clam-drops to hard surfaces, presumably due to sensitivity to the invariants created when the clam hits the various available surfaces. To take an example from the kinesthetic realm: There is much research showing that the length of a (uniform) rod is specified by the “moment of inertia,” which is detectable when the rod is moved in certain ways. (Roughly speaking, it is the degree to which the rod resists angular movements). People who are instructed to judge the length of rods they cannot see, actively move the rods in ways that create resistance to angular movements, and they are thereby quite accurate in judging rod length (Carello & Turvey, 2015). Like the optic and vibratory patterns produced when a dropped clam hits a rock, the resistance to rotation is not present absent the actions of the organism.

This principle can be further expanded to the realm of social interaction: For example, when studying the interaction of adult ground squirrels with rattlesnakes, which will prey on squirrel young, it was found that squirrels actively engage the snakes in a way that produces optic patterns specific to the level of danger afforded by the snake (i.e., whether the snake was spry or lethargic at that moment, Owings, Rowe, & Rundus, 2002). The squirrels’ detections of such properties of the snake are not independent of a complicated social interaction that the squirrels become more proficient at over time (Owings & Coss, 1977).

**Key Point**

*Any evolutionary approach to perception must have, as an essential element, something equivalent to Gibson's organism-environment dynamics.* It must be the case that action and perception are not treated as separate steps in a linear sequence, but rather as cyclical processes.[[9]](#footnote-9) An evolutionary theory of perception must do more than simply acknowledge that perception and action are sometimes cyclical, in more-complex perceptual scenarios. Any future theory must acknowledge perception-action cycles as essential to the most evolutionarily foundational perceptual scenarios.

*This opens the opportunity for specific research programs not commonly found in perceptual research.* Despite progress by some researchers, we know almost nothing about the role of exploratory motion in providing animals with access to specific energy patterns. The best successes in ecological psychology involve kinesthetic exploration of objects, and while there are good successes with other modalities, they are few (see, for example, Mantel, Stoffregen, Campbell, & Brady, 2015; Mark, Jiang, King, & Janina, 1999; Stoffregen & Mantel, 2015). This is a place where fundamental research discoveries still wait in abundance.

**Other Points to Consider**

It is worth noting related aspects of the ecological approach that may be of interest to evolutionary theorists, but need not be essential to future theories: Some ecological psychologists have shown particular interest in pushing a more radical interpretation of Gibson’s system, in which they try to explain all human activity in terms of these perceptual dynamics. In so doing, they try to deny that traditional notions of cognition are necessary to explain any aspect of psychology.[[10]](#footnote-10) It is true that any ecologically and evolutionarily grounded theory will necessarily entail dynamics that allow perceptual explanations to apply to a far wider swath of activity than is covered by more traditional perceptual theories, however, it is not essential that future evolutionary theories of perception take a side on the more radical debate.

**Element 4: Attunement and Affordances**

[In this approach] the puzzle of meaning and value in perception takes an entirely new form. If what things afford is specified in the light, sound, and odor around them... then the learning of new meanings is an education of attention rather than an accrual of [remembered] associations. (Gibson, 1966, p. 320)

The perceptual abilities of organisms change on both evolutionary and developmental time scales. Once perception is understood as an adaptation to the existence of structured energy, we can understand these evolutionary and developmental processes as “tuning” the perceptual systems of organisms, including tuning the behavioral systems that are dynamically entwined with perception. No one would, however, expect evolutionary or developmental processes to make organisms equally good at detecting all possible patterns. Both evolutionary processes and processes of perceptual learning, entail becoming the type of organism that more reliably distinguishes energy patterns specific to *behaviorally relevant* properties of the environment. The shift towards seeing the world as composed of behaviorally relevant elements, leads to the concept of “affordances.”

Especially in the fields of animal behavior and child development, discussions of affordances have drawn a large proportion of Ecological Psychology’s attention. (And Daniel Dennett, 2017, declared “affordances” as his #1 “Scientific term or concept that ought to be more widely known.”) Affordances, roughly speaking, are properties of the environment that provide opportunities for action to a give organism (Jones, 2003). A better description would be that affordances are properties of the organism-environment system, whereby organism can effect specific change in the environment (Chemero, 2011). This makes the level of analysis on which Ecological Psychology works inherently functional, in the pragmatic sense (Noble, 1981). A cup at reachable distance, for example, affords “picking up” for organism of a specific size with a specific hand shape. Gibson would eventually claim that organisms, at the most fundamental level, perceive affordances: The invariants to which organisms are sensitive are those which specify behavioral opportunities.

The “affordance” concept is not, as is sometimes presented, a fundamental assumption of the ecological system. It is, rather, a conclusion drawn from the system’s evolutionary, developmental, and ecological grounding. If you believe that organisms have evolved to better fit their environments, and you believe that such a process of adaptation includes the evolution of their perceptual systems, then you would *conclude* that perception should, to the extent possible, be designed so as to facilitate actions relevant to a particular species. If you further believe, as any evolutionary theory of psychology must (see above), that there is structured energy that specifies properties of the environment, then it follows that evolution will have tuned animals to be adept at differentiating those energy patterns specific to behaviorally relevant properties of the organism-environment system. Perceptual learning must, via different mechanisms, lead to similar improvements in the tuning of perceptual systems (i.e., see Adolph & Kretch, 2015, for several points similar to those made in this article, but with a focus on developmental processes). Without those developmental and evolutionary processes, there would be no way for organisms to act adaptively towards the objects and events that surround them.

The concept of affordances thus connects perceptual development and evolution with the organism becoming more accurate at discriminating the environment in ways directly relevant to the organism's short-term and long-term success. As organisms learn to perceive better, they are inherently learning how to act better, and visa-versa. That is why Gibson would eventually claim that it was concrete opportunities for action (affordances) that were directly perceived, rather than meaning-neutral object properties (as might be described by a physicist).

The notion of affordances, and the suggestion that affordances are perceived, has caused many people to be extremely skeptical about the scientific possibilities for Ecological Psychology. In an important sense, the notion of affordances places meaning into the external environment and it blurs the subjective-objective distinction (Gibson, 1979); critics see both of those points as strong causes of concern. The analysis presented here, keeping ecological claims in focus, may help to alleviate some of those concerns: If a vine of a certain thickness affords climbing support to a given animal, say a lemur, then to the extent that the vine’s thickness is specified in the structure of light, it is also true that *the climability of the vine for that specific individual animal* is specified. Both the substrate that make the affordance possible and the substrate that make perception of the affordance possible are present in the ecology of the animal. As that animal's ancestors evolved, and as that individual animal grew, its perceptual system developed in a way that attuned it to discriminate vine widths in terms of their potential as climbing support. After the fact, you find an adult animal who, when looking at a vine, *sees* whether or not the vine provides the opportunity to climb. It is in this way that the affordance concept can be said to cut across the subjective-objective distinction, while requiring no reference to any phenomena that are not treated as concretely objective in more traditional analyses.

**Key Point**

*Any evolutionary approach to perception must have, as an essential element, something equivalent to Gibson's notion of affordances.* That is, there must be a theory regarding what types of things organisms particularly evolved in order to perceive – as distinct from the things they can incidentally perceive as a result of having evolved sensory organs. That theory must further recognize that organisms will have evolved perceptual systems in order to be able to better act with regards to the behavioral opportunities relevant to their evolutionary niche.

*This opens the opportunity for specific research programs not commonly found in perceptual research.* Much of the best research in ecological psychology has focused around the affordance concept, by studying the sensitivity of people to opportunities to act. Time and time again, the sensitivity is found to be remarkable (a broad survey of this work can be found in the *Studies in Perception and Action* series). In addition, many persistent mysteries regarding perception have been solved by approaching relevant experiments with an eye towards the affordances involved (for example, the so-called size-weight illusion can be explained in terms of how throwable the relevant objects are, e.g., Zhu & Bingham, 2011). While this represents the strongest area of success for ecological psychologists, there is also an incredible expanse of research opportunities still untapped.

**Other Points to Consider**

It is worth noting related aspects of the ecological approach may be of interest to evolutionary theorists, but need not be essential to future theories: When Gibson introduced the idea of affordances in 1966, it clearly came as the logical outcome of much reasoning about the environmental support for perception and about developmental and evolutionary processes. That is, it was not a foundational assumption, but a conclusion derived from prior postulates (as presented above). Since then, affordances have come to have a more central place in the ecological reasoning (e.g., Gibson, 1979, E. Gibson & Pick, 2000). Some ecological psychologists would go so far as to claim that perception is inherently and exclusively “of affordances,” and they will sometimes talk about affordances as if they make up some sort of fundamental (ontological) category of things found in the world (e.g., Michaels & Carello, 1981). It should be clear from the discussion above, that the concept of affordances can be used with or without such implications. Thus, while any evolutionary theory of psychology will need an equivalent to Gibson’s notion of affordances, it is not essential that they limit perception to affordances, nor that they claim any special philosophical status for affordances. It is not even important that future theories use the affordance term, so long as they retain the core insight that perceptual systems must have evolved to distinguish action-relevant properties of the organism-environment system.

**Conclusion**

Any evolutionary grounded approach to perception must include an understanding of structured ambient energy, be able to account for variations in the perceptual systems of different species, incorporate organism-environment dynamics, and recognize evolutionary and development attunement to affordances. These crucial elements of any future theory were brought together for the first time by James Gibson, in *The Senses Considered as Perceptual Systems*,which formally launched the system that came to be known as Ecological Psychology. However, while I have illustrated these elements using examples from the ecological approach, the elements can be exapted into future evolutionary theories of perception without necessarily importing other aspects of the ecological approach. This is, in fact, happening with increased regularity as functionally oriented psychologists and philosophers work towards more evolutionarily grounded approaches to our field. Each of these principles represents not just an essential element of an evolutionary theory of perception, but also a realm of empirical research that is rich with yet-to-be-made discoveries. As psychology becomes more evolutionarily oriented, these concepts, and their associated research areas will become more central to the field.

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1. The 1300 page Handbook of Evolutionary Psychology (Buss, 2015), for example does not have a single chapter on perception, and the handful of pages listed in the index focus on “misperceiving” social cues. [↑](#footnote-ref-1)
2. Note that two-path theories in cognitive psychology try to have it both ways, by hypothesizing a neurological path that leads to action that is independent of a path that leads to higher mental functioning. While worth acknowledging, dual-path theories do not address the primary concerns of this paper. [↑](#footnote-ref-2)
3. While there are numerous exceptions here and there, as the field of cognitive research is very broad, the most notable systematic exception to this observation would be in the heuristic-cognition literature. That literature gives significant attention to how cognitive “shortcuts” can act as highly functional adaptations to a world structured such that those habits of decision making typically work well. Such an argument requires giving almost as much consideration to the ethological context of decision making as it does studying the decisions themselves (e.g., Gigerenzer and Todd, 1999). [↑](#footnote-ref-3)
4. Note that the “transforms” metaphor works best if you are considering the light that converges onto the moving organism. If you instead frame things in terms of the environment in which the organism is moving, then the “sampling” metaphor is more appropriate. Whether analyzed from an “objective” (organism-independent) point of view, or from the point of view of a particular organism, the ecological focus remains on the patterns of energy in the ambient light itself. [↑](#footnote-ref-4)
5. The literature of ethology is composed largely of studies of such imperfect actions towards the environment; such as a territorial robin that will readily attack a red tuft of fuzz held up by brown wire; or the nesting goose that will role any white egg-sized object into its nest, even if it is almost square in shape. Beyond that, the literature of operant and classical conditioning are largely about how arbitrarily most organisms can come to act towards most aspects of their environments, should a reliable correlation between events be maintained for a sufficient duration. [↑](#footnote-ref-5)
6. Not only is the idea of structured energy extendable to other sensory domains, but it is equally possible to talk of structure in patterns of energy across domains (e.g. Stoffregen & Bardy, 2001, and the accompanying commentary). [↑](#footnote-ref-6)
7. It is tempting to say that any approach must *have* “ecological optics.” I avoid that phrasing here because I am more concerned about the ideas that are Gibson's legacy than about his terminology, or whether he is explicitly credited by all future theories. [↑](#footnote-ref-7)
8. Gibson (1966) anticipated that his use of this term “information” would be problematic, and indeed it has caused much confusion. Gibson made it clear that this use of the term “means *information about*, or *specification of*,” and that “not all structure carries this sort of information” (p. 187). Because it is so susceptible to confusion, and because other terms are available, I will not refer to “information” anywhere else in this paper, and will instead refer to specification and structure. [↑](#footnote-ref-8)
9. This dynamic view of perception is quite similar to the epigenetic approach to physiologicaland behavioral development (e.g., Miller, 1997; Wagman & Miller, 2003). [↑](#footnote-ref-9)
10. For example, Natsoulous wrote about the potential of subsuming memory completely into perception within the Ecological Approach (e.g. Natsoulous, 1987-88). See also discussion in Reed, 1988, p. 298-309. [↑](#footnote-ref-10)