Reconciling Evolutionary Psychology and Ecological Psychology: How to Perceive Fitness Affordances

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Following Charles Darwin (1871), evolutionary psychology has analyzed the origins and functions of complex psychological adaptations. Following Egon Brunswik (1956) and J. J. Gibson (1979), ecological psychology has analyzed the adaptive fit between organisms and environments with regard to perception, judgment, and action. Despite their common bio-functional orientation, these fields have developed in almost total isolation from each other. This paper tries to integrate their conceptual and empirical strengths by introducing the notion of 'fitness affordances' – objects and situations in the environment that carry potential fitness costs and benefits (negative or positive implications for survival or reproduction), and that can be avoided or exploited behaviorally by animals of a particular species. The fitness affordance idea grounds perceptual theory firmly in evolutionary biology, solves many traditional problems in epistemology, integrates diverse empirical work in evolutionary and ecological psychology, and offers new directions forward for 21st century research on sensation, perception, cognition, emotion, and decision-making.

Keywords: ecological psychology, functionalism, social affordances, specification.

进化心理学与生态心理学的整合：理解适宜可用性

进化心理学源自达尔文进化论，以分析心理机能及起源为主要研究目的。同样，生态心理学在 Brunswik(1956)和 Gibson(1979)开创引领下，探讨了有机体的知觉、判断、行为等因素在环境适应中的作用。尽管进化心理学和生态心理学都具有生物机能主义倾向，但过去研究较少探讨二者联系。该文引入适宜可用性观点来整合进化心理学和生态心理学的理论与实证研究。适宜可用性的观点认为，生存与繁衍问题中的代价与利益分析有助于特定种群的动物采取趋近或回避行为来保证潜在适宜性。适宜可用性的观点源自进化生物学中的知觉理论，它解决了认识论中许多传统问题，也整合了进化心理学和生态心理学的实验研究成果。适宜可用性的观点为新世纪的感觉、知觉、认知、情绪和决策的研究提供了新的理论基础。

关键词：生态心理学，机能主义，社会适宜性，特化

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Introduction

What are brains and minds for? Before evolutionary psychology, each behavioral science offered a different answer to this question. To clinical psychologists, human minds are for fixing – making people mentally healthier and happier. To cognitive psychologists, minds are for processing information accurately, according to the procedural norms of rationality and statistical inference. To economists, human minds are for maximizing subjective expected utility through the consumption of goods and services. Each science had trouble talking to the others because they had such different assumptions about the mind's functions, which led to interest in different behavioral phenomena, different research methods, and different criteria for judging theories. There was no scientific 'consilience' (theoretical coherence and scope – Wilson, 1998), because there was no consensus about function.

Since the rise of evolutionary psychology, we know what the mind is for: reproduction. We know this because, from a Darwinian point of view, all biological adaptations, whether eyes, kidneys, knees, ovaries, or brains, are ultimately for reproduction (Darwin, 1871). Adaptations can arise through evolution only by promoting the reproductive success of the genes that code for the adaptations (Dawkins, 1982). Of course, these adaptations promote reproduction in very different ways – some directly (ovaries are for making eggs, which get fertilized to produce babies); some indirectly (eyes are for seeing, to help guide reproduction-promoting behaviors). The functional study of anatomy and physiology in medicine is largely the study of how, exactly, specific organs promote reproduction – often (though not always) through promoting survival (Cannon, 1932).

Until recently, however, there was no analogous functional study of the human mind – no recognition that reproduction was the ultimate arbiter of success or failure for all psychological processes, including perception, cognition, learning, memory, emotion, motivation, and motor behavior (Darwin, 1871; Tooby & Cosmides, 1990, 1992).

How exactly do brains and minds promote reproductive success? My research has been guided by two central ideas about the human mind's reproductive functions – the idea of 'fitness affordances' (Barrett et al., 2005) and the idea of 'fitness indicators' (Geher & Miller, in press; Miller, 2000a,b,c, 2001; Miller & Todd, 1998; Shaner, Miller, & Mintz, 2004). Both ideas may help guide fruitful research across a wide range of psychological domains, and may inspire psychologists in China – who will be crucial to the future success of evolutionary psychology (Miller, 2006a,b) – to pay more attention to species-specificity, domain-specificity, content-specificity, context-specificity, and individual differences in behavior. My previous papers have explained fitness indicators, but not the 'fitness affordance' concept. The time seems right to address it here, because the concept may help reconcile the two great biologically-oriented, functional traditions in the study of human behavior: ecological psychology (Brunswik, 1956; Gibson, 1979), and evolutionary psychology (Tooby & Cosmides, 1992).

The Idea of Affordances

The notion of 'fitness affordances' is a Darwinized, updated version of J. J. Gibson's (1966, 1979) concept of perceptual 'affordances'. Gibson's new term 'affordance' referred to things in the environment that 'afford' various behavioral interactions because they offer perceivable cues and actionable opportunities concerning potential costs and benefits to the organism. For example, for a typical primate, fruit 'affords' eating, trees 'afford' climbing, and snakes 'afford' danger. In ecological psychology following Gibson, registering affordances is the whole point of perception and cognition, and acting upon affordances is the whole point of motor behavior (Chemero, 2003; Kadar & Effken, 1994; Reed, 1996; Turvey, 1992).

Gibsonian ecological psychology has been influenced by many schools of thought, including the American pragmatism of William James (1912) and John Dewey (1896), the European phenomenology of Martin Heidegger (1927) and Maurice Merleau-Ponty (1962), the probabilistic functionalism of Egon Brunswik (1943, 1956), the focus on environment structure in the study of bounded rationality (Simon, 1956), and biologically-oriented, naturalistic, functionalist traditions in philosophy of science

(Godfrey-Smith, 1996; Millikan, 1984). The guiding question in each tradition was: how can real moving animals interact adaptively with biologically important objects in their natural environments – specifically, how can they perceive 'external objects' as meaningfully related to their own capacities for acting upon those objects to promote their own interests and concerns?

The key insight in each tradition was that in most ordinary activity, we do not perceive a world composed of objects and their physical or sensory features (as the empiricist, constructivist traditions in perception claim – see Norman, 2002). Rather, we perceive a world composed of opportunities and threats, of actionable situations. For example, when a peasant wakes up to get dressed in the morning, he does not perceive his boots as merely physical objects (600-gram assemblages of leather and rubber); he perceives the boots as things-to-be-grabbed, things-to-put-upon-the-feet, and things-to-lace-up (Heidegger, 1927). This ordinary view of the boots as affordances for wearing-on-the-feet is usually disrupted only by behavioral error (e.g. one misses grabbing the boot due to a hangover), object failure (e.g. the boot-laces break), or idle chatter (e.g. one talks pretentiously about the boot's 'objective' nature as a physical object). Most of the time, for most animals, in most domains of behavior, the world is experienced as a set of meaningful, actionable opportunities – not a set of 'physical objects' and their 'sensory features'.

(We humans can perceive the world in this sensory-physical way sometimes, because we have language, which yields social and sexual payoffs for talking creatively about the sensory-physical features of external objects apart from their normal biological meanings – Miller, 2000a. For example, we can observe a distant elongated cloud in the sky, and note that it resembles Gansu province, thereby demonstrating our vision capacities and geographical knowledge to a potential mate. In this case, the cloud – which we would never ordinarily notice or perceive – becomes an opportunity for idle chatter during verbal courtship. The radical view of Gibsonian ecological psychology implies that most non-flying animals never perceive distant clouds, because they have no means of acting upon them or in response to them. Clouds only became affordances for us because we can talk about them.)

This Gibsonian perspective leads to a new ontology for the behavioral sciences based on biologically relevant affordances rather than physical objects (Kadar & Effken, 1994; Turvey, 1992). 'Ontology' is just a fancy word for the kinds of things that we bother to talk about. Different sciences need different ontologies. Physicists need to be able to talk about physical things in terms of matter and energy. Biochemists need to be able to talk about biochemical

things in terms of genes and proteins. Psychologists, according to the Gibsonian perspective, need to be able to talk about psychological things in terms of affordances – how they are perceived and acted upon, and how they influence the survival and reproductive prospects of particular animals. In this pluralist, pragmatist view, lower-level physical entities are no more real or foundational or objective than higher-level psychological affordances. Protons are not more real than predators. Proteins are not more real than potential mates. Of course, predators can be viewed as having 'emergent properties' of their biochemical or physical constituents, but the emergent properties (e.g. the saber-toothed cat's ability to bite through one's throat with its 18-cm canines) are just as real as the constituents (e.g. the calcium salts that form the canine enamel). Indeed, to all intents and purposes, the emergent properties are *more* real at the psychological level of description than the physical constituents – it is not the calcium salts that kill the cat's victim; it is being bitten through the throat.

The affordance concept from Gibson has influenced mostly the fields of visual perception (Shepard, 1984, 2001), adaptive decision-making (Cosmides & Tooby, 1996; Todd & Gigerenzer, 2000), neuroethology (Comer & Robertson, 2001; Emery, 2000), and work on embodied, situated, and dynamical cognition (Barsalou, 1999; Smith & Semin, 2004; Van Gelder, 1998; Wilson, 2002). It has guided some functionally-oriented neuroscience research on the relationship of perception to motor control (Grezes & Decety, 2001). It has also inspired much applied work on autonomous adaptive agents, neural networks, artificial life, and robotics (Anderson, 2003; Webb, 2001).

Against the Direct Perception Dogma

Unfortunately, this Gibsonian tradition has not much influenced evolutionary psychology so far. One reason is that Gibsonian ecological psychology posits the 'direct perception' of affordances – the brain's supposed ability to 'resonate' to affordances (like a tuning fork resonates to ambient sound frequencies) without doing any information processing of any sort (Gibson, 1979). Since the rise of cognitive psychology, the computer metaphor for mind, and perceptual neuroscience, this tuning-fork metaphor has seemed hopelessly naïve (Fodor & Pylyshyn, 1981; Ullman, 1981). If vision does not require any information-processing, why is a third of the human brain devoted to vision? It would seem more efficient to attach the primary visual cortex directly to the premotor cortex. Historically, evolutionary psychology arose as a cognitivized form of 1970s sociobiology, which combined traditional Darwinian functional analyses of animal behavior and the new cognitive psychology attention to information-

processing mechanisms (Tooby & Cosmides, 1990, 1992). Evolutionary psychology was basically Richard Dawkins (1982) plus David Marr (1982): 'psychological adaptations' could be analyzed through a combination of gene-oriented evolutionary-functional analysis and information-oriented computational analysis (Geary, 2005). As it turned out, this strategy proved wildly successful (Buss, 1995, 2005).

However, since ecological psychology showed an obdurate attachment to the 'direct perception' dogma, and denied the need for any internal processing of biologically relevant cues to perceive biologically meaningful affordances, it seemed to offer nothing to the new computationally oriented evolutionary psychology. Thus, evolutionary psychologists borrow bits and pieces of the naturalistic tradition in perception (e.g. using Brunswik's 'lens model' of cue integration to understand mate choice – Miller & Todd, 1998), but never found the 'affordance' concept very promising, since it was associated with the seemingly bizarre doctrine that perception does not require any information-processing. Instead, evolutionary psychology has largely adopted the sensation-based theories of perception derived from the philosophical tradition of British empiricism dating back to John Locke (1632-1704). This tradition has dominated experimental psychology ever since Hermann von Helmholtz, Gustav Fechner, and Wilhelm Wundt (Barsalou, 1999; Norman, 2002). To make the 'affordance' concept relevant to contemporary (i.e. cognitively-oriented) evolutionary psychology, ecological psychology must abandon the direct perception dogma.

Against the Specification Dogma

Another assumption in Gibsonian ecological psychology has been that the external world contains sufficiently rich information that it uniquely 'specifies' all available affordances (Barsalou, 1999; Stoffregen & Bardy, 2003). For example, the 'ambient optic array' (the entire pattern of light through which an animal moves) was claimed to uniquely specify the climbability of stairs (Warren, 1984), and the catchability of balls (Peper et al., 1994). This 'specification' claim – that all affordances are fully, uniquely, and unambiguously specified by perceptual information available in the environment – is a very strong claim indeed. It became another dogma in ecological psychology, although it never made any sense to perceptual psychologists steeped in the sensation-based constructivist tradition from Helmholtz through Marr (1982). In the constructivist tradition, the proximal pattern of light available in the ambient optic array vastly under-specifies the distal environmental objects that must be perceived, and this is precisely why animal vision must rely on

'unconscious inferences' – complex computations that are cognitively impenetrable to the perceiver (Pylyshyn, 1999), and that rely upon rich innate assumptions about the world's causal and statistical structure (Kersten et al., 2004; Shepard, 2001). It is also why building robot vision systems is a challenging problem in computer programming and statistical pattern recognition (DeSouza & Kak, 2002; Jain et al., 2000).

True, lab-bound perception researchers often under-estimate the information available in the natural ambient optic array, and the ease of registering that information to guide certain physical movements (Gibson, 1979). But ecological psychologists equally under-estimate the difficulty of a brain being wired to 'resonate' reliably to external affordances without having complex internal processing (Fodor & Pylyshyn, 1981; Ullman, 1981).

Yet there is a much more fundamental problem with the specification dogma: many affordances in the environment have hugely important costs or benefits that cannot possibly be inferred or learned from direct personal experience of their perceivable appearance (Shepard, 2001; Tooby & Cosmides, 1990, 1992). For example, natural selection but not personal experience can register the genetic inbreeding costs of incest, and favor sexual aversion to siblings (Lieberman et al., 2003). Similarly, psychological adaptations for sperm competition can be favored by sexual selection but not by personal observations of competing sperm in Fallopian tubes (Shackelford et al., 2005). Analogous problems arise for any affordances that yield fitness costs or benefits through processes that are too microscopic in scale, too delayed in time, or too lethal in outcome, to be observed directly – including the infection costs of microscopic germs (Navarrete & Fessler, 2006), the longevity benefits of anti-oxidant molecules in fruits (John et al., 2002), and the death costs of being bitten by venomous snakes (Isbell, 2006). Nonetheless, we have evolved psychological adaptations that embody unconscious knowledge about the expected fitness costs and benefits of such situations. In other words, the most important affordances cannot be learned by individuals simply through experience; species must evolve sensitivities to such affordances over evolutionary time.

The rest of this paper considers what evolutionary psychology could gain by adopting an improved notion of Gibsonian affordances – one that abandons the 'direct perception' and 'specification' dogmas. Instead, this improved notion of 'fitness affordances' embraces the cognitive/computational view of perceptual mechanisms as complex information-processing adaptations, and the evolutionary-functional view that the most important fitness costs and benefits of affordances must be internalized by natural selection, not by individual learning.

Fitness Affordances in Evolutionary Psychology

The term 'fitness affordance' is not used commonly yet, but the combination of Gibsonian ecological perception theory and Darwinian functional analysis that it represents has informed evolutionary psychology and related disciplines in many areas.

These influences are apparent in many studies of ecological perception and human preferences that drive the adaptive exploitation of natural resources such as:

- natural landscapes (Fischer & Shrout, 2006; Kaplan, 1987; Stamps, 2004),
- water (Burmil et al., 1999; Verhaegen et al. 2002; Wheeler, 1992);
- trees (Kappeler, 1998; Povinelli & Cant, 1995);
- animals (Kahn, 1997; Rakison & Poulin-Dubois, 2001; Wilson & Kellert, 1995);
- meat (Finch & Stanford, 2004; Rose & Marshall, 1996);
- herbs, spices, and medicines (Billing & Sherman, 1998; Hart, 2005);
- psychoactive drugs (Newlin, 2002; Sullivan & Hagen, 2002)

In most of these research areas, evolutionary psychologists have tried to understand both the objective structure of the environment (e.g. Brunswik's 'cue validities') and the subjective use of environmental information (e.g. Brunswik's 'cue utilization').

Similar ecological and evolutionary influences are apparent in studies of perception and behavior in relation to social and sexual 'resources' (i.e. other people) based on cues of their:

- physical attractiveness (Gangestad & Simpson, 2000; Langlois et al., 2000)
- intelligence (Geher & Miller, in press; Prokosch et al., 2005)
- creativity (Bressler et al., 2006; Haselton & Miller, 2006; Nettle & Clegg, 2006)
- personality traits (Figueredo et al., 2005; Nettle, 2005)
- moral virtues (Griskevicius et al., submitted; Miller, submitted)
- mental health (Keller & Miller, in press; Shaner et al., 2004)
- self-esteem (Brase & Guy, 2004; Leary & Baumesiter, 2000)

Most such studies recognize the relationship-specificity of social affordances: particular individuals can be viewed as relatives, friends, lovers, allies, enemies, in-group members, or out-group members, and different traits become salient for each role.

Fitness Affordances are Species-specific

The Darwinized version of Gibson's concept clarifies what should count as 'cost' or 'benefit', and thus what should count as an affordance, for a

particular animal of a particular species: anything that potentially affects an animal's survival or reproduction, and that can be influenced by the animal's motor behavior (Barrett et al., 2005). Positive fitness affordances, including water, food, shelter, sexual partners, relatives, and offspring, typically promote survival or reproduction. Negative fitness affordances, such as predators, pathogens, parasites, and sexual competitors, typically interfere with survival or reproduction. Animals evolve nervous systems so they can approach and exploit the positives, and avoid the negatives. If something in the environment does not afford any behavioral interaction of any sort that can influence one's evolutionary success, it is not worth perceiving. Whereas Gibson (1979) emphasized inanimate, physical affordances in the environment, a fully Darwinized version of the affordance concept must put even greater importance on the animate and 'social affordances' that mediate reproductive success in highly social species such as ours (Costall, 1995; Good & Still, 1989).

Fitness affordances are highly species-specific, and depend upon the existing morphological, physiological, and behavioral adaptations of a given animal. For Cantonese human cooks, "Anything that walks, swims, crawls, or flies with its back to heaven is edible" (as the famous saying goes) – including the sea cucumber (hai shen) – whereas this delicacy would not be perceived as an attractive fitness affordance by the leaf-eating Guizhou snub-nosed monkey (*Rhinopithecus brelichi).* Likewise, *Mamenchisaurus jingyanensis* (a 25-meter-long plant-eating dinosaur discovered in Sichuan) may have been an attractive fitness affordance (as food) for *Yangchuanosaurus shangyouensis* (a 3-meter-tall meat-eating dinosaur), but not for *Sinosauropteryx prima* (a smaller, weaker, 0.5-meter-tall meat-eater). Actress Zhang Zi Yi (章子怡) would be an attractive fitness affordance (as a potential sexual partner) for most male humans, but not for a female giant panda (*Ailuropoda melanoleuca).* Jade (翡翠) is a highly valued fitness affordance (as a status symbol) for humans, but means nothing to the Chinese lake dolphin (*Lipotes vexillifer).* In each case, the perceived fitness affordance would not just be registered as an external object, but would unleash a cascade of goal-oriented movement planning and decision-making – the *Yangchuanosaurus* might imagine how to chase and kill the *Mamenchisaurus*; the male human might imagine how to win the heart of Zhang Zi Yi, or own a jade statue from the Shanghai Museum. Thus, each animal species' nervous system should evolve to take into account that species' own survival and reproductive issues, focusing its perception, attention, emotions, and consciousness on the fitness affordances that matter most given its ecological, social, and sexual niche. This perspective is widely used in comparative psychology, animal behavior research, and neuroethology, but is rarely emphasized in human psychology.

Fitness Affordances are Individual-specific

If the species-specificity of fitness affordances was the only relevant principle from evolutionary psychology, we might expect the human nervous system to be rather simple: genetically hard-wired to focus on a few salient environmental stimuli (e.g. meat, flint, genitals, babies, tigers) that can be exploited or avoided by a few simple behaviors (e.g. eating, flint-knapping, copulating, breast-feeding, running and screaming). Instead, we have a 100-billion-neuron, 1250-cc brain that processes extremely complex information. Why? Because the most important fitness affordances – those that concern survival, social, sexual, and family life – are not only species-specified, but are also specific to one's stable individual traits (age, sex, physical attractiveness, intelligence, personality, etc.), one's transient conditions (states of thirst, hunger, fatigue, health, etc.), and one's social context (family situation, sexual relationships, friendships, social status, culture, economy, physical environment). This is why the central nervous system integrates information from the external environment (sensation) with information about the body's current physiological states (interoception – Craig, 2003a,b,), and internal working models of one's individual traits compared to others (e.g. self-esteem, self-assessed strength, attractiveness, intelligence, and status – Leary & Baumeister, 2000).

This is where evolutionary psychology gets much of its power as a meta-theory (Ketelaar & Ellis, 2000). It can identify fitness affordances that have different perceptual cues, behavioral implications, and fitness costs or benefits depending on these complex background variables – and it can thereby predict age differences, sex differences, health differences, family-context differences, and even cross-cultural differences in human behavior (Buss, 1995). Thus, the human mind's function is not just to register a few fitness affordances as 'releasing stimuli' and to react with 'fixed action patterns' (as classical ethologists suggested), but to use a vast suite of complex psychological adaptations to register a vast array of fitness-relevant contextual information about a wide range of fitness indicators (see Buss, 2005). This relentless attention to the individual-specificity and context-specificity of fitness indicators is the main reason why evolutionary psychology is not simplistic 'genetic reductionism'.

Example: Potential mates as fitness affordances given mutual mate choice and individual differences in mate value

The mutuality of human mate choice imposes many complexities on our mating decisions (Buss, this issue; Miller, 2000a; Miller & Todd, 1998), and these influence how we perceive potential mates as fitness affordances. In most mammal species, females are choosy and males are not; whereas in humans, both sexes are choosy about forming the long-term sexual relationships that result in most offspring. Thus, both men and women can experience rejection, heartbreak, and jealousy. This results in a competitive 'mating market' for both sexes, in which individuals of high 'mate value' (who are attractive, intelligent, high-status, and sane) tend to pair up with other individuals of high mate value, leaving lower-mate-value individuals no choice but to pair up with each other (Todd & Miller, 1999). The outcome is 'assortative mating' for overall mate value.

Given this mating market context, an individual of much higher mate value than oneself is quite likely to reject one's courtship attempts, so any such courtship is likely to be futile (and to cost considerable time, energy, and embarrassment). Therefore, each individual has incentives to learn their overall mate value (e.g. as they mature in adolescence), and to focus their courtship effort on potential mates who are most likely to reciprocate their interest (Penke et al., in press; Simao & Todd, 2002). From this point of view, we can understand why many Chinese men may have dreams and sexual fantasies about movie stars, but fall in love with much lower-mate-value local women who represent a better investment of actual courtship effort – and therefore a more promising fitness affordance, given the men's own limited mate value.

These selection pressures to be realistic about one's own mating prospects probably drove the evolution of human 'self-esteem' mechanisms as ways of tracking one's relative social status and sexual attractiveness in the local mating market (Gangestad & Simpson, 2000; Leary & Baumeister, 2000). However, since mate value has several separable (if positively correlated) dimensions, one's self-esteem should also include several domain-specific components that differentially influence one's behavioral strategies in sex-specific and age-specific ways (Brase & Guy, 2004; Kirkpatrick et al., 2002; Todd, Billari, & Simao, 2005), and that have clinical implications for treating depression (Allen & Badcock, 2003; Ben Hamida, Mineka, & Bailey, 1998). For example, self-esteem regarding one's physical attractiveness may be more important to young, single people, whereas self-esteem regarding the status and honor of one's extended family may be more important to old, married people. The young may be more depressed by physical flaws, whereas the old may be more depressed by familial shame. Thus, from the simple observation that human mate choice is mutual, and mate value is multi-dimensional, it has been possible to develop rich predictive theories about the functions, domains, sex differences, and clinical effects of self-esteem. Such insights may also explain the persistence of higher self-esteem in males, with the largest sex difference occurring in late adolescence, near the peak of mating effort (Kling et al., 1999).

Fitness Affordances are Domain-specific

Apart from being species-specific and individual-specific, most fitness affordances are very domain-specific: they represent actionable opportunities for advancing or defending one's evolutionary fitness through a quite restricted set of behavioral possibilities. For normal human females, bai cai (白菜) affords cooking and eating (and hence survival), and actor Zhou Run Fa 周润发 (of *Wo hu cang long – Crouching Tiger, Hidden Dragon*) affords romance and sex (and hence reproduction). It would be a serious category error to seduce bok choy or to eat Yun-Fat Chow. The domain-specificity of fitness affordances derives from the evolutionarily ancient, highly structured relationships between environmental objects, behavioral possibilities, and fitness implications. Bok choy (*Brassica chinensis*) has been selectively bred for edibility over thousands of years since the domestication of its ancestral form (*Brassica rapa*). The 6'1" (1.85 meter) tall, athletically built Yun-Fat Chow is the outcome of selective breeding (by female mate choice) for physical attractiveness and charisma over thousands of years since the self-domestication of *Homo sapiens* (Miller, 2000a). Millenia of selection by choosy female orifices have shaped each of their perceivable cues (astringent crispness or cock-sure manliness) and actionable qualities (chewability or copulability) at many levels of organization, from the microscopic level (e.g. high levels of vitamin A, beta carotene, and glucosinolates in bok choy; high levels of testosterone and N-acetyl-aspartate in Yun-Fat Chow's brain – see Hammond et al., 2001; Yeo, Brooks, & Jung, 2006) to the macroscopic level (e.g. long, thick stalks). These tight fits between perceivable cues, actionable qualities, and fitness implications yield the highly domain-specific structure of the lived human environment.

Fitness affordances tend to be structured hierarchically into domains (e.g. food vs. mates), categories (e.g. vegetables vs. meat), species (e.g. bai cai versus luo bo （萝卜）, and exemplars (e.g. this bok choy on my plate vs. that bok choy on your plate). This hierarchical structure probably reflects a progressive phylogenetic differentiation of sensory and motor capabilities. Very simple nervous systems may distinguish only between threats (negative

affordances that provoke avoidance) and opportunities (positive affordances that provoke approach). More complex nervous systems evolve capacities for making finer discriminations among fitness affordances that can guide more specialized affordance-exploiting behaviors. Thus, as nervous systems evolve ever greater complexity, the fitness affordances that they can perceive and act upon evolve to be ever more numerous, diverse, and domain-specific.

The domain-specificity of fitness affordances has a close relationship to their species-specificity. Sometimes trade-offs arise between being able to exploit one type of resource (food or mate) versus another type of resource. When this happens, evolution usually just splits species apart: speciation produces two new species, one better able to exploit one resource and the other better able to exploit the other resource. This is the source of all biodiversity: the progressive differentiation of species to exploit their econiche-specific fitness affordances. However, with larger-brained, longer-lived animals, evolution sometimes does not result in speciation, but in more differentiated and flexible behavioral capacities. In essence, the behavioral speciation occurs within the brain of one species through the increased domain-specificity of perception and action within each individual, and through the increased psychological differentiation and division of labor across individuals with different personality traits. Humans, as generalist omnivores capable of technological adaptation to almost any terrestrial habitat, embody the widest range of behavioral capacities, and hence the widest sensitivity to the greatest number of domain-specific fitness affordances.

Fitness Affordances are Objectively Relational

Together, the species-specificity, individual-specificity, and domain-specificity of fitness affordances can make them sound quite subjective in nature – as little more than threats and opportunities in the eye of the beholder. However, Gibson (1979) clearly viewed affordances as objectively existing properties of the world – they just exist in relation to a particular animal's interests and capabilities. Thus, affordances are 'objectively relational': they really do exist whether an animal perceives them or not, but their perceivable cues, actionable properties, and fitness implications will all be relative to each animal.

This may sound confusing at first, but almost everything that humans care about exists on this objectively relational level. For example, a man may have a lovely wife, and she is objectively his wife even if he gets amnesia and forgets about her; but her being his wife is a relational property – she is his wife, and not anyone else's. Conversely, many assistant professors would like to own a BMW 550i sedan, but cannot afford one, and that is an objectively true statement about the relationship between the BMW's retail price ($57,400) and the typical assistant professor's bank account balance (rather less than $57,400). Thus, most important fitness affordances in life – especially human relationships – are neither 'subjective' nor 'objective', but objectively relational.

The 'fitness' modifier in front of 'affordances' emphasizes their objectively relational nature, because 'fitness' itself concerns an objective relationship between organism and environment. Low fitness implies a statistical propensity on the part of an organism to die without offspring in a particular environment. High fitness implies a statistical propensity to flourish and breed in a particular environment. So, a 'fitness affordance' is an objectively relational way to improve one's objectively relational success in an environment.

This perspective solves many traditional problems in epistemology (philosophical studies concerning the reliability of human perception and knowledge). Ever since the Enlightenment, the rise of physical sciences, and Cartesian dualism, Western epistemology and psychology have struggled to connect subjective human experience to the 'objective' world of physics. The dominant assumption was that only matter and energy are real, and everything else that we perceive is subjective, illusory, and unreliable – like Zhuong Zi (庄子) dreaming he is a butterfly. Even such biologically significant, psychologically salient 'constructs' as food, danger, and children were considered fallible projections by a biased, error-prone observer – unwarranted inferences guided by the Western philosophies of Locke's associative experiences or Kant's innate ideas. In this physicalist world-view, there is no evolutionary process that connects subjective experience to objective environmental threats or opportunities at any level of description above the merely physical. There is no room for objectively relational phenomena in general, or fitness affordances in particular.

By contrast, the fitness affordance world-view sees food, danger, and children as objectively, subjectively, relationally, functionally, and evolutionarily fundamental – they are the 'real stuff' of the world, the things worth perceiving and acting upon. Atoms and photons can also become genuine fitness affordances as well, and hence psychologically real, not because they are metaphysically or objectively more fundamental than food or children, but because we can observe them with scanning electron microscopes and photodetectors, and we can manipulate them through chemistry and optics. Insofar as chemists can mess around with atoms to make money to buy their children food, safety, and education, atoms are genuine fitness affordances too.

They are just no more fundamental than the children themselves.

This shift from a physics-centered view to a fitness-affordance view also has a Darwinian feminist dimension. The prototypical Western epistemologist was an alienated middle-aged male philosophy professor sitting in an arm-chair, alone in his study, wondering how he could achieve any genuine connection to the outside world – while his wife and servants cooked, cleaned, and cared for children elsewhere. Since the rise of Darwinian feminism (Hrdy, 1997; Vandermassen, 2004), this male-focused image has been challenged. Perhaps a more ancestrally typical epistemological situation is that of a bright, young mother, sitting near a fire, talking with friends, breast-feeding a baby, wondering how she can achieve greater intimacy with her slightly autistic, philosophically-preoccupied boyfriend. The mother is epistemologically well-connected to the fitness affordances that surround her, because she is engaged in meaningful, fitness-promoting activities. The alleged chasm between subject and object does not seem very deep or wide to breast-feeding mothers. By contrast, the male armchair philosopher is not well-connected because he is alone and idle, untroubled by threats and unmotivated by opportunities. He wallows in solipsism while his children miss their daddy, his wife misses her lover, and his servants doubt his sanity. These are objectively relational facts about his life, but he overlooks them, because he only believes in physics.

Conclusion

The fitness affordance idea offers a way to reconcile evolutionary psychology and ecological psychology, by rejecting the traditional Western philosophical dogma that the real world is essentially physical and meaningless, and only derivatively and subjectively meaningful. Evolutionary biology suggests on the contrary that for large, clever animals such as us, the world is full of genuine fitness affordances that exist far above the physical level of description, and it is our job to perceive and interact adaptively with them. These fitness affordances include food, predators, and parasites; landscapes, shelters, and tools; family, friends, lovers, children, and groups. These Confucian fundamentals are all species-specific, individual-specific, domain-specific, and objectively relational in nature – but they are supremely real, important, and meaningful nonetheless. Their reality and relevance is eternally, omnisciently, omnipotently enforced by natural selection itself, which is the ultimate arbiter of our ontology and our epistemology. Their fitness implications are not 'specified' by the environment itself, but by our ancestral history of interactions with them. They cannot be perceived 'directly', but

through complex, inference-based psychological adaptations of exquisite computational power and awesome adaptive fit to the causal and statistical structure of the environment. Future research in evolutionary psychology – which will occur mostly in Asia (Miller, 2006a,b) – may progress most rapidly by adopting the Euro-American insights of Darwin, Brunswik, and Gibson, but rejecting the European philosophies of Descartes, Locke, and Kant. It would be better to focus on how we perceive and act upon the fitness indicators in front of us: boots that need lacing, bok choy that needs cooking, jade that needs carving, babies that need breast-feeding, and tenure that needs getting.

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