Evolutionary Psychology

Evolutionary psychology is an approach to the cognitive sciences in which evolutionary biology is integrated with the cognitive, neural, and behavioral sciences to guide the systematic mapping of the species-typical computational and neural architectures of animal species, including humans.

Although the field draws on many disciplines, of particular importance was the integration of (1) the cognitive study of functional specializations pioneered in perception and Chomskyan psycholinguistics (MARR 1982); (2) hunter-gatherer and primate studies (Lee and DeVore 1968); and (3) the revolution that placed evolutionary biology on a more rigorous, formal foundation of replicator dynamics (Williams 1966; Dawkins 1982). Beginning in the 1960s, this revolution catalyzed the derivation of a set of theories about how evolution shapes organic design with respect to kinship, foraging, parental care, mate selection, COOPERATION AND COMPETITION, aggression, communication, life history, and so forth -- theories that were refined and tested on an empirical base that now includes thousands of species. This body of theory has allowed evolutionary psychologists to apply the concepts and methods of the cognitive sciences to nontraditional topics, such as reciprocation, foraging memory, parental motivation, coalitional dynamics, incest avoidance, sexual jealousy, and so on. Evolutionary psychology is unusual in that a primary goal is the construction of a comprehensive map of the entire species-typical computational architecture of humans, including motivational and emotional mechanisms, and that its scope includes all human behavior, rather than simply "cold cognition."

George Williams's (1966) volume *Adaptation and Natural Selection* was of particular formative significance to evolutionary psychology. Williams identified the defects in the imprecise, panglossian functionalist thinking that had pervaded evolutionary biology and that continues, implicitly, to permeate other fields. The book outlined the principles of modern adaptationism (see ADAPTATION AND ADAPTATIONISM), showed how tightly constrained any adaptationist (i.e., functionalist) or by-product claim had to be to be consistent with neo-Darwinism, and identified the empirical tests such claims had to pass. Until Williams, many biologists explained the existence of a trait (or attributed functionality to traits) by identifying some beneficial consequence (to the individual, the social group, the ecosystem, the species, etc.). They did so without regard to whether the functionality or benefit was narrowly coupled, as neo-Darwinism requires, to a design that led to systematic genic propagation of replicas of itself within the context of the species' ancestral environment. Evolutionary psychologists apply these precise adaptationist constraints on functionalism to the cognitive, neural, and social sciences, and maintain that cognitive scientists should at least be aware that many cognitive theories routinely posit complex functional organization of kinds that evolutionary processes are unlikely to produce.

Evolutionary psychologists consider their field methodologically analogous to reverse engineering in computer science. In such an enterprise, evolutionary psychologists argue, knowledge of the evolutionary dynamics and ancestral task environments responsible for the construction of each species' architecture can provide valuable, although incomplete, models of the computational problems (sensu Marr 1982) that each species regularly encountered. These, in turn, can be used to pinpoint many candidate design features of the computational devices that could have evolved to solve these problems, which can then be used to guide empirical investigations. For example, if eye direction reliably provided useful information ancestrally about the intentions of conspecifics or predators, then specialized eye direction detectors may have evolved as a component of SOCIAL COGNITION, and it may prove worthwhile testing for their existence and design (Baron-Cohen 1995).

Evolutionary psychologists consider it likely that cognitive architectures contain a large number of evolved computational devices that are specialized in function (Gallistel 1995), such as FACE RECOGNITION systems, a language acquisition device, navigation specializations, and animate motion recognition. They are skeptical that an architecture consisting predominantly of content-independent cognitive processes, such as general-purpose pattern associators, could solve the diverse array of adaptive problems efficiently enough to reproduce themselves reliably in complex, unforgiving natural environments that include, for example, antagonistically coevolving biotic adversaries, such as parasites, prey, predators, competitors, and incompletely harmonious social partners.

Selection drives design features to become incorporated into architectures in proportion to the actual distribution of adaptive problems encountered by a species over evolutionary time. There is no selection to generalize the scope of problem solving to include never or rarely encountered problems at the cost of efficiency in solving frequently encountered problems. To the extent that problems cluster into types (domains) with statistically recurrent properties and structures (e.g., facial expression statistically cues emotional state), it will often be more efficient to include computational

specializations tailored to inferentially exploit the recurrent features of the domain (objects always have locations, are bounded by surfaces, cannot pass through each other without deformation, can be used to move each other, etc.). Because the effects of selection depend on iteration over evolutionary time, evolutionary psychologists expect the detailed design features of domain-specific inference engines to intricately reflect the enduring features of domains. Consequently, evolutionary psychologists are very interested in careful studies of enduring environmental and task regularities, because these predict details of functional design (Shepard 1987). Adaptationist predictions of DOMAIN SPECIFICITY have gained support from many sources, for example, from cognitive neuroscience, demonstrating that many dissociable cognitive deficits show surprising content-

specificity, and from developmental research indicating that infants come equipped with evolved domain-specific inference engines (e.g., a NAIVE PHYSICS, a THEORY OF MIND module; Hirschfeld and Gelman 1994).

A distinguishing feature of evolutionary psychology is that evolutionary psychologists have principled theoretical reasons for their hypotheses derived from biology, paleoanthropology, GAME THEORY, and hunter-gatherer studies. Such theoretically derived prior hypotheses allow researchers to devise experiments that make possible the detection and mapping of computational devices that no one would otherwise have thought to test for in the absence of such theories. To the extent that the evolutionary theory used is accurate, evolutionary psychologists argue that this practice allows a far more efficient research strategy than experiments designed and conducted in ignorance of the principles of evolved design or the likely functions of the brain. Using this new research program, many theoretically motivated discoveries have been made about, for instance, internal representations of trajectories; computational specializations for reasoning about danger, social exchanges, and threats; female advantage in the incidental learning of the spatial locations of objects; the frequency format of probabilistic reasoning representations; the decision rules governing risk aversion and its absence; universal mate selection criteria and standards of beauty; eye direction detection and its relationship to theory of mind; principles of generalization; life history shifts in aggression and parenting decisions; social memory; reasoning about groups and coalitions; the organization of jealousy, and scores of other topics (see Barkow, Cosmides, and Tooby 1992 for review).

Although some critics (Gould 1997) have argued that the field consists of post hoc storytelling, it is difficult to reconcile such claims with the actual practice of evolutionary psychologists, inasmuch as in evolutionary psychology the evolutionary model or "explanation" precedes the empirical discovery and guides researchers to it, rather than being constructed post hoc to explain some known fact. Although critics have also plausibly maintained that reconstructions of the past are inherently speculative, evolutionary psychologists have responded that researchers know with certainty or high confidence thousands of important things about our ancestors, many of which can be deployed in designing cognitive experiments: our ancestors had two sexes; lived in an environment where self-propelled motion reliably predicted that the entity was an animal; inhabited a world where the motions of objects conformed to the principles of kinematic geometry; chose mates; had color vision; were predated upon; had faces; lived in a biotic environment with a hierarchical taxonomic structure; and so on. Moreover, evolutionary psychologists point out that, to the extent that reconstructions are uncertain, they will simply lead to experiments that are no more or less likely to be productive than evolutionarily agnostic empiricism, the alternative research strategy.

Similarly, critics have argued that adaptationist analysis is misconceived, because adaptations are of poor quality, rendering functional predictions irrelevant (Gould 1997). Evolutionary psychologists respond that although selection does not optimize, it demonstrably produces well-engineered adaptations to long-enduring adaptive problems. Indeed, whenever engineers have attempted to duplicate any natural competence (color vision, object recognition, grammar acquisition, texture perception, object manipulation, locomotion over natural terrains, language comprehension, etc.), even when using huge budgets, large research teams, and decades of effort, they are unable to engineer artificial systems that can come close to competing with naturally engineered systems.

The processes of evolutionary change divide into two families: chance and selection. Chance processes (drift, mutation pressure, environmental change, etc.) produce random evolutionary change, and so cannot build organic structure more functionally organized than chance could account for. Natural selection, in contrast, is the only component of the evolutionary process that sorts features into or out of the architecture on the basis of how well they function. Consequently, all cognitive organization that is too improbably well-ordered with respect to function to have arisen by chance must be attributed to the operation of selection, a constrained set of processes that restrict the kinds of functional organization that can appear in organisms. As a result, features of a species' cognitive or neural architecture can be partitioned into adaptations, which are present because they were selected for (e.g., the enhanced recognition system for snakes coupled with a decision-rule to acquire a motivation to avoid them); by-products, which are present because they are causally coupled to traits that were selected for (e.g., the avoidance of harmless snakes); and noise, which was injected by the stochastic components of evolution (e.g., the fact that a small percentage of humans sneeze when exposed to sunlight). One payoff of integrating adaptationist analysis with cognitive science was the realization that complex functional structures (computational or anatomical), in species with life histories like humans, will be overwhelmingly species-typical (Tooby and Cosmides 1990a). That is, the complex adaptations that compose the human COGNITIVE ARCHITECTURE must be human universals, while variation caused by genetic differences are predominantly noise: minor random perturbations around the species-typical design. This principle allows cross-cultural triangulation of the species-typical design, which is why many evolutionary psychologists include cross-cultural components in their research.

Evolutionary psychologists emphasize the study of adaptations and their by-products not because they think all or most traits are adaptations (or their side effects), but because (1) at present, adaptationist theories of function provide clear and useful prior predictions about cognitive organization; (2) the functional elements are far more likely to be species-typical and hence experimentally extractable; (3) analysis of the random or contingent components of evolution provides very few constrained or falsifiable predictions about cognitive architecture; and (4) theories of phylogenetic constraint are not yet very useful or well developed, although that may change. Evolutionary psychologists do not maintain that all traits are adaptive, that the realized architecture of the human mind is immune to modification, that genes or biology are deterministic, that culture is unimportant, or that existing human social arrangements are fair or inevitable. Indeed, they provide testable theories about the developmental processes that build (and can change) the mechanisms that generate human behavior.

See also

- ALTRUISM
- EVOLUTION
- MODULARITY OF MIND
- SEXUAL ATTRACTION, EVOLUTIONARY PSYCHOLOGY OF
- SOCIAL COGNITION IN ANIMALS
- SOCIOBIOLOGY

-- *Leda Cosmides and John Tooby*

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