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Evolutionary Psychology: Applications and Criticisms

Introductory article

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Theories from evolutionary biology have many implications for research in the cognitive sciences. Evolutionary psychologists have been using these theories to guide their research, the goal of which is to map the evolved, species-typical cognitive and neural architecture of humans (and other species).

INTRODUCTION

Evolutionary psychology (EP) is a paradigm that can be applied to any issue in psychology, rather than a subfield built around the study of a single topic such as vision, social psychology, or child development. As a result, evolutionary theories have opened up many previously unexplored research areas to investigation. Moreover, topics that have already been explored from other perspectives can be advanced empirically and theoretically by adding an evolutionary perspective to the mix. This is because few (if any) of the mechanisms that make up the human mind/brain have been completely mapped. Evolutionary analyses of the adaptive functions that a mechanism evolved to perform usually provide specific hypotheses about its as yet unmapped and undetected design features, prompting further discoveries. Even if the mechanism under study were fully mapped, a correct theory of its adaptive function would still be needed to explain how it came to exist, and why it has the computational design that it does; and to identify which of its components are design features (i.e., functional components), which are incidental byproducts of the mechanism's functional design, and which are evolutionary accidents. In this way, EP is playing the central role in transforming psychology from a largely atheoretical collection of findings to a discipline with principled explanations for why the components of the mind/brain have the designs that they do.

APPLICATIONS OF EVOLUTIONARY PSYCHOLOGY

Heuristic Role of Evolutionarily Derived Predictions

A feature that distinguishes evolutionary psychology from other approaches is that researchers have principled theoretical reasons for their hypotheses derived from evolutionary biology, paleoanthropology, game theory, and hunter–gatherer

studies. Such theoretically derived hypotheses allow researchers to devise experiments that make possible the detection and mapping of mechanisms that no one would otherwise have thought to test for in the absence of such theories. Evolutionary psychologists argue that this practice allows a far more efficient research strategy than experiments designed and conducted without reference to the likely functions of the brain. A key insight that emerges from integrating psychology with evolutionary biology is that the mechanisms that psychologists study are adaptations – mechanisms that acquired their organization because that arrangement solved adaptive problems for our ancestors (i.e., had an adaptive function). This insight links the study of psychological mechanisms to theories of adaptive function developed in evolutionary biology. This, in turn, allows a large number of predictions to be derived about the design of human information-processing mechanisms from the large pre-existing body of theories already developed and empirically tested within modern evolutionary biology.

Using this new research program, many theoretically motivated discoveries have been made concerning, for example, internal representations of trajectories; social reasoning specializations; 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 understanding others' mental states; 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. Several examples are discussed in more detail below.

Social Exchange and Cheater Detection

Sometimes known as reciprocal altruism, social exchange is an 'I'll scratch your back if you scratch mine' principle: *X* provides a benefit to *Y* conditional on *Y* doing something that *X* wants. This mutual provisioning of benefits, each conditional on the other's compliance, is rare in the animal kingdom: some species (e.g., humans, vampire bats, chimpanzees, baboons) have the cognitive machinery necessary to engage in this behavior, whereas others do not. Robert Trivers, W. D. Hamilton, Robert Axelrod and other evolutionary researchers used game theory to understand the conditions under which social exchange can and cannot evolve. For adaptations causing this form of cooperation to evolve and persist, cooperators must have mechanisms that perform certain specific tasks. For example, reciprocation cannot evolve if the organism lacks reasoning procedures that can effectively detect cheaters (those who take conditionally offered benefits without providing the promised return). Such individuals would be open to exploitation, and hence selected out. Based on such analyses, Leda Cosmides and John Tooby hypothesized that the human neurocognitive architecture includes social contract algorithms: a set of circuits that were specialized by natural selection for solving the intricate computational problems inherent in adaptively engaging in social exchange behavior, including a subroutine for cheater detection.

Because conditionally delivered behavior requires conditional reasoning for its regulation, Cosmides and Tooby used the Wason selection task, an experimental protocol developed to study conditional reasoning, in order to test for the presence of social contract algorithms and their predicted properties. The Wason selection task asks subjects to look for violations of a conditional rule (*If P then Q*), such as 'If a person eats hot chili peppers, then he will drink a cold beer'.

A conditional rule is violated whenever *P* happens but *Q* does not happen (in this case, whenever someone ate hot chili but did not drink cold beer). In the Wason task, the subject is given incomplete information about four people (in this case, one ate hot chili peppers (*P*), one ate broccoli (*not-P*), one drank cold beer (*Q*), one drank hot tea (*not-Q*)). To respond correctly, the subject would need to investigate the person who ate chili and the person who drank hot tea (i.e., *P* and *not-Q*). Yet studies in many nations have shown that reasoning performance on descriptive rules like this is low: only 5–30 percent of people give the logically correct answer, even when the rule involves familiar terms drawn from everyday life.

To show that people who ordinarily cannot detect violations of conditional rules can do so easily when the rule expresses a social contract and a violation represents cheating would be (initial) evidence that the mind has reasoning procedures specialized for detecting cheaters.

Evolutionary psychologists found just that pattern: people who ordinarily cannot detect violations of if-then rules can do so easily and accurately when that violation represents cheating in a situation of social exchange. Given a rule of the general form, 'If you take benefit B, then you must satisfy requirement R' (e.g., 'If you borrow my car, then fill up the tank with gas'), people will point to

the person who accepted the benefit and the person who did not satisfy the requirement – the individuals who represent potential cheaters. The adaptively correct answer is immediately obvious to almost all subjects, who commonly experience a pop-out effect. No formal training is needed. Whenever the content of a problem asks one to look for cheaters in a social exchange, subjects experience the problem as simple to solve, and their performance jumps dramatically. In general, 65–80 percent of subjects get it right, the highest performance found for a task of this kind. Further experiments showed that this does not occur because social contracts activate logical reasoning, but because they activate a differently patterned, specialized logic of social exchange. On social exchange problems when formal logic (i.e., the propositional calculus) and social exchange logic predict different answers, subjects overwhelmingly follow the evolved logic of social exchange.

Many cognitive scientists have now investigated social contract reasoning, and many of the predicted design features have been tested for and found. For example, the mind's automatically deployed definition of cheating is tied to the perspective one has adopted, for the reasoning enhancement to occur, the violations must potentially reveal cheaters; if detecting violations of social contracts reveals only innocent mistakes, enhancement does not occur. Perhaps the strongest evidence that there is a neural specialization designed for cheater detection is the discovery that cheater detection can be selectively impaired by brain damage, without impairing other reasoning abilities. If social contract reasoning were a byproduct of a more general ability to reason, one could not lose the specific ability without also suffering damage to the general ability supposedly responsible for it. Consistent with its being a species-typical ability, social contract reasoning effects are found across cultures, from industrial democracies to hunter–horticulturalist groups in the Ecuadorian Amazon. Most surprisingly, people are just as good at detecting cheaters on culturally unfamiliar or imaginary social contracts as they are for ones that are completely familiar, providing a challenge for any counterhypothesis resting on a general-learning skill acquisition account. (*See* **Reasoning**)

Foraging and Sex Differences in Spatial Ability

Before 1992 there were hundreds of studies published on sex differences in spatial abilities. Not one showed a replicable female advantage in spatial abilities, and many showed a male advantage.

While evolutionary psychologists do not assume that male and female psychological architectures must be identical in all respects, they do think that whatever differences exist will reflect the different distributions of tasks faced ancestrally by men and women (when they do not reflect differential treatment during development). If there was stronger selection for ancestral women for some spatial tasks, and stronger selection for ancestral men for others, this would produce female superiority in some tasks, and male superiority in others. Starting from an adaptationist perspective, Irwin Silverman and Marion Eals asked a question no spatial researcher had ever asked before: what kind of spatial cognition is required to be good at gathering plant foods? Finding plant foods is a predominantly female activity in foraging populations, and it poses different spatial problems than hunting. Unlike animals, plants do not change location. They do, however, develop over time: a vine, herb, bush, or tree yielding nothing edible now will bear ripe and edible fruit, nuts, tubers, or leaves later in the year. To be an efficient forager, therefore, one must be good at encoding and remembering the locations of thousands of different plants within a complex spatial array. Ideally, this information should be learned incidentally, as one goes about other activities.

Silverman and Eals designed spatial tests that could assess this ability. Some of these tests involved pictures of objects in a complex array, others involved objects in a room. Regardless of format, women consistently recalled more objects than men did. More critically, however, women were more accurate than men at recalling the locations of these objects. This held even controlling for the fact that women recalled more objects: given that an object was recalled, women's location memory was more accurate. This female advantage was large – about as large as the male advantage in tests of mental rotation – and it was found even in incidental learning paradigms.

A century of evolutionarily agnostic approaches to spatial cognition had failed to find a female advantage for any spatial task. But the first time evolutionary psychologists asked what kind of spatial problems ancestral women would have had to solve to forage efficiently, they were able to discover a new spatial ability that shows a large female advantage. As a paradigm, EP allows one to ask more specific questions about the computational design of cognitive sex differences without these being euphemisms for the age-old question of

which sex is 'better'. With an adaptationist focus, questions of better or worse quickly disappear and are replaced with questions about the possible functions of a trait, design features predicted by those functions, and empirical data that confirm or falsify confirm those design features. (*See* **Spatial Cognition, Psychology of**)

Coalitional Psychology: Is Race Encoding a Reversible Byproduct of Coalition Encoding?

Ingroup favoritism paired with outgroup indifference or hostility exists in all human cultures. Field and laboratory studies have shown that this behavior is easy to elicit: the simple act of categorizing individuals into two social groups predisposes humans to discriminate in favor of their ingroup and against the outgroup in both allocation of resources and evaluation of conduct. This occurs even when subjects are assigned to groups temporarily and anonymously by an experimenter who used dimensions that are trivial, previously without social significance, and random with respect to any real characteristics of the individuals assigned. Given that categorizing people into groups along nearly any dimension elicits discrimination, it would be discouraging to find that the human mind cannot help but categorize people on the basis of their race.

Yet, social psychologists had reluctantly concluded that the human mind has circuits that automatically encode (notice and remember) the race of each individual we encounter, as a normal part of impression formation. This conclusion was based on years of experiments in which researchers had searched in vain for ways to weaken the tendency for subjects to categorize others by race. However, the idea that automatic racial categorization is an evolved feature of the human mind is implausible from an evolutionary point of view. Our hunter–gatherer ancestors would rarely – if ever – have encountered a person of a different race, so natural selection could not have favored brain mechanisms designed to notice and remember a non-existent dimension of ancestral social life. This line of reasoning implies that race encoding is a side-effect of a mechanism designed to detect something else that was important for our ancestors.

Accordingly, Robert Kurzban and colleagues proposed and tested an alternative hypothesis: that the (apparently) automatic and mandatory encoding of race is instead a byproduct of brain mechanisms that evolved for an alternative function that was a regular part of the lives of our foraging ancestors: detecting coalitions and alliances. Hunter–gatherers lived in bands, and neighboring bands frequently came into conflict with one another. Similarly, there were coalitions and alliances within bands, a pattern found in related primate species and likely to be more ancient than the hominid line. Mechanisms designed to track these shifting alliances would have benefited our ancestors by helping them to predict the likely social consequences of alternative courses of action.

Brain mechanisms for detecting coalitions should identify patterns of coordinated action, cooperation, and competition. But behaviors that reveal who is allied with whom are rare; to allow judgments even when such events are not in process, coalition encoding mechanisms should note and boost the saliency of any perceptually available marker that is correlated with coalitional alliance. Otherwise arbitrary cues – such as accent, skin color, or manner of dress – should pick up significance only insofar as they acquire predictive validity for coalitional membership. In societies that are not completely racially integrated, shared appearance – a highly visible and always present cue – may be correlated with patterns of association, cooperation, and competition. Under these conditions, coalition detectors may perceive (or misperceive) race-based social alliances, and the mind will map 'race' onto the cognitive variable *coalition*.

Using the same unobtrusive measures that had led social psychologists to believe race encoding is intractable, Kurzban *et al*. showed that race encoding is instead a reversible byproduct of coalition encoding. By creating a social context in which race was not predictive of a cooperative alliance, evolutionary psychologists were able to drastically decrease the extent to which subjects encoded race. Even a few minutes' exposure to a world in which race no longer predicted alliance was enough to substantially deflate the tendency to notice and remember another's race. The experiments also confirmed predictions about the design features of the coalition detection system. Without being asked to do so, subjects nevertheless spontaneously grouped persons into coalitions, noticing and remembering who was affiliated with whom. They did so even in the absence of common appearance, simply on the basis of expressions of mutual ingroup support and outgroup emnity. Other conditions with appearance cues confirmed that the mind appears designed to pick up any perceptual marker, however arbitrary, that is correlated with patterns of cooperation and alliance. The same marker is ignored when it is not correlated with

coalition. Humans appear to have an evolved coalition detection system.

Relevance of Evolutionary Psychology to Psychiatric Syndromes

Evolutionary psychologists argue that the paradigm provides fresh insight into psychiatric syndromes. According to Jerome Wakefield, the (implicit) consensus view in medicine is that disorders are conceptually defined as harmful dysfunctions. That is, to qualify as a disorder, a syndrome must consist of damage to one or more adaptations, and people must make the value judgment that these effects are harmful. (For example someone may suffer damage to their adaptations for incidentally learning plant locations or coalitional affiliations but neither notice nor care.)

This places the study of adaptations – computational ones in the case of mental illnesses, noncomputational ones in the case of other illnesses – at the center of medicine. Autism, for example, appears to involve a breakdown in the psychological mechanisms that allow one individual to interpret the mental states of others. Some syndromes, such as postpartum depression, gestational diabetes, and the food aversions of pregnancy sickness, may not be disorders at all, but the expression of adaptations. Others – such as phobias to snakes and spiders – may result from a dysfunctional overactivation of an adaptive system designed to reduce poisonous bites among our foraging ancestors. Yet others may result from a mismatch between modern environments and the ancestral world our mechanisms evolved to operate in. For example, fat storage as a buffer against occasional famine – adaptive for a hunter–gatherer – may lead to obesity in calorie-abundant environments.

Example: postpartum depression

One fact about the past that researchers know with certainty is that raising offspring was, for both parents, very costly in terms of time and energy. These costs are particularly high when a baby is born. Nursing alone requires approximately an additional 500 calories per day above and beyond what the mother needs for herself. Our ancestors had to forage for all their food, and studies of hunter–gatherers and other primates indicate that food would often have been scarce. A mother in an ancestral foraging society would have benefited greatly from food and other assistance provided by the father and other family members, especially if she also had other children.

Robert Trivers pointed out that investment of scarce resources in one offspring decreases the investment that can be made in other offspring (or future offspring). In the unforgiving world of our ancestors, attempting to raise a newborn without sufficient food and help from others would sometimes have led to the death of the mother or her other children, or might have damaged her ability to have any future children. In the environment of evolutionary adaptedness, mothers who reduced or eliminated investment in offspring that were unlikely to survive and reproduce due to poor health or insufficient parental resources would have been able to increase their investment in other offspring that were more likely to survive and reproduce, and thus would have had a greater number of total descendents than mothers who invested in all offspring equally.

Martin Daly, Margo Wilson, Janet Mann, and Edward Hagen have argued that our ancestors would have been under heavy selection pressure to evolve a motivational system that evaluated the availability of resources, social support, and the health of the newborn to regulate the sentiments in a new mother that decide whether or not to expend her scarce resources on the newborn. Because in humans, evolved decision-making processes are often experienced as emotions, evolutionary psychologists predict that mothers with sufficient resources, social support, and a healthy baby will feel positive emotions towards the newborn, and will therefore invest in it. In contrast, mothers with low levels of resources, social support, or a very unhealthy baby may experience negative emotions towards the newborn (and a corresponding lack of positive emotions), and will therefore reduce their investment in it, saving this investment for other (or future) offspring that are more likely to survive and reproduce.

Postpartum depression (PPD), which is characterized by sustained low mood, sadness, loss of interest, and other symptoms, is suffered by about 10 percent of all mothers, and has been universally regarded as a mental illness, one probably caused as a byproduct of abnormal hormone fluctuations. A close look at PPD from an evolutionary perspective, however, suggests that it is not a disorder, because it exhibits a series of design features that would have been too functional in the world of our ancestors to have appeared by accident. PPD operates in a manner consistent with what would be expected in an adaptation whose function is to reduce investment in the newborn when there are insufficient resources and social support, or when the infant has serious health problems suggesting

that it would not survive and reproduce in a foraging world. Studies by Hagen and others have confirmed that PPD is associated with lack of social support, lack of resources, and infant health problems, and that mothers with PPD reduce their investment in their newborns. Many studies have failed to find any association between PPD and abnormal hormone fluctuations, and the conclusion that PPD is not caused by abnormal hormonal fluctuations is strengthened by the fact that fathers (who, unlike mothers, are not experiencing dramatic hormonal changes) also suffer PPD. Even though mothers in industrialized countries typically have enough food, they nevertheless inherit adaptations designed to be sensitive to the availability of social support, a resource that would have been critical to successfully raising a child in ancestral environments. When this essential resource is in short supply, it would have been evolutionarily adaptive for mothers to lower their interest in their newborn.

Because this is a new theory, it cannot form the basis for clinical interventions in PPD cases without considerable further testing. If this theory turns out to be true, however, it suggests that treatment of PPD should not consist of antidepressants alone, but should instead involve the judicious use of antidepressants in concert with providing the mother with what she needs: more social support and resources. (*See* **Depression**)

CRITICISMS OF EVOLUTIONARY PSYCHOLOGY

Storytelling

Some critics, such as Stephen Jay Gould, have argued that the field consists of post-hoc storytelling ('just-so stories'). It is difficult to reconcile such claims with the actual practice of EP, since in evolutionary psychology the evolutionary model or prediction typically precedes and causes the discovery of new facts, rather than being constructed post hoc to fit some known fact. Of course, all scientific fields from physics to geology also entertain new explanations for already known facts, and evolutionary psychology is no exception. However, new theories for already known facts almost always make new predictions that other theories do not, allowing them to be tested against each other. For example, race encoding was a known phenomenon, but the theory that it was a byproduct of coalitional specializations led to new predictions. Indeed, the value of any new scientific paradigm is measured by its ability to explain findings that other paradigms could not explain, by its ability to explain large sets of facts economically, and by its ability to make novel and significant predictions that are subsequently confirmed by observation.

Though evolutionary psychology is a young science with relatively few practitioners, its researchers have (1) predicted, tested for, and found, a large number of previously unknown mechanisms, whose existence was predicted in advance by evolutionary theory; (2) advanced theories that explain previously unexplained phenomena; (3) advanced theories that provide economical and unified explanations for previously unconnected findings.

Falsifiability

Another common assertion has been that evolutionary hypotheses are unfalsifiable, a claim that is sometimes justified by arguing that the evolutionary past cannot be observed. Evolutionary psychologists reply that there are two components to their theories: (1) hypotheses about the psychological architecture of modern humans; and (2) hypotheses about the ancestral selection pressures that designed the architecture.

Saying a mechanism evolved by natural selection to solve a particular function makes specific and testable predictions about the present design features of that mechanism. (For example humans will exhibit an enhanced ability to reason about cheaters, which can be selectively impaired while other reasoning abilities stay intact. When tested, women will exhibit an advantage in incidentally learning the locations of things.)

Only the second component (ancestral selection pressures) involves phenomena that are difficult to observe directly. In analyzing ancestral selection pressures, EP draws heavily on knowledge about ancestral environments, and critics have plausibly maintained that reconstructions of the past (which routinely go on in astronomy, geology, physics, and biology) are inherently speculative. This would be a problem if researchers had to have complete information about all aspects of the ancestral world to make progress. However, while some features of the ancestral world are difficult to investigate, researchers know with certainty or high confidence thousands of important things about our ancestors, many of which can be used to derive falsifiable predictions about our psychological architecture: our ancestors had two sexes; contracted infections by contact; collected plant foods; 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, etc. To the extent that reconstructions are uncertain or erroneous, they will simply lead to experiments that are no more or less likely to be productive than the blind guessing of evolutionarily agnostic empiricism, the alternative research strategy.

How Good are Adaptations?

Critics have argued that adaptationist analyses are misconceived, because (they assert) natural selection is a weak force in evolution, making adaptations poor, and rendering functional predictions irrelevant. However, researchers point out that the empirical record shows that selection regularly produces very well-engineered adaptations to long-enduring adaptive problems, providing a solid empirical foundation for analyzing the human psychological architecture in functional terms. Whenever engineers have attempted to duplicate any natural human competence (color vision, object recognition, grammar acquisition, texture perception, object manipulation, 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. It seems illogical to assert as a theoretical precept that evolved systems are poorly designed when human engineers cannot produce anything nearly as good.

Why is Function Emphasized?

Because EP emphasizes function, critics have argued that proponents think that all traits are adaptive. This is untrue, either in theory or in practice (for example Kurzban *et al*.'s argument above is that race encoding is a byproduct, not an adaptation). Although evolutionary psychologists do not think all – or even most – traits are adaptations, they do emphasize the study of adaptations and their byproducts for four reasons.

1. Adaptationist theories of function provide clear and useful prior predictions about cognitive organization.
2. The functional elements of an adaptation are far more likely to be species-typical, making them easier to discover through experimentation.
3. Very few constrained or falsifiable predictions about cognitive architecture follow from analyses of the random or contingent components of evolution.
4. As yet, there are few, if any, useful or well-developed theories of non-adaptive constraint.

Finally, evolutionary psychologists do not maintain that the developed 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.

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