

EVOLUTIONARY PSYCHOLOGY

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INTRODUCTION

Evolutionary psychology aims to document, understand and interpret human behavior using an evolutionary perspective. In other words, evolutionary psychologists argue that human psychology cannot be fully understood without considering the selective forces that have shaped that behavior in our evolutionary past, and that may continue to do so in the present. Although the traditional branches of psychology (e.g. cognitive, developmental, social, clinical) have until recently largely ignored evolutionary perspectives, proponents argue that the evolutionary perspective has the potential to provide a coherent and comprehensive theoretical framework – Darwin's theory of evolution by natural selection – that underpins all these various subdisciplines. Evolutionary psychology is therefore arguably best seen, not as a distinct field within psychology, but as a general approach that spans psychology. In order to understand how the evolutionary approach is relevant to the various subdisciplines of psychology, the four levels of explanation for behavior proposed by the ethologist Tinbergen is a useful model. This describes how any behavior can be understood in terms of its development and mechanism ('proximate' explanations) as well as in terms of its function and phylogenetic origins ('ultimate' explanations). Evolutionary psychologists are especially interested in ultimate explanations for behavior, while other subdisciplines tend to be especially interested in proximate explanations. However, Tinbergen's point is that these lines of enquiry must be integrated to obtain a complete understanding of the behavior. The evolutionary approach is grounded within the same theoretical background that is used by biologists to describe animal behavior. Key theoretical principles therefore include natural and sexual selection at the individual level, kin selection and inclusive fitness, life history theory, reciprocal altruism, mate choice, and parent-offspring conflict. In addition to these, evolutionary psychologists are interested in aspects of behavior that are notably developed or well-studied in humans, such as the origins and development of language and the evolution of culture.

GENERAL OVERVIEWS

For an accessible introduction for the layperson, Dunbar et al. 2005 is a good place to start. Workman and Reader 2008 is good for students from a psychology background. Buss 2012 is the most recent and fullest undergraduate level text. Barrett et al. 2002 is particularly useful for understanding the differences between and complementary contributions of human behavioral ecology and evolutionary psychology. Several edited volumes provide deeper treatments of particular issues. Barkow et al. 1992 essentially launched the field. Buss 2005 contains a collection of articles dealing with core issues and approaches. Crawford and Krebs 2008 is also a wide-ranging and comprehensive treatment of issues and applications. Finally, Dunbar and Barrett 2007 covers both the well-studied areas within evolutionary psychology research, as well as broader spectrum articles connecting these areas with current findings and thinking in neurobiology and comparative psychology.

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Barkow, J. H., L. Cosmides, and J. Tooby, eds. 1992. *The adapted mind: Evolutionary psychology and the generation of culture*. Oxford University Press.

The first edited volume on evolutionary psychology, a classic text which established the field.

Provides evolutionary psychology theory and evidence on a wide range of topics, from cooperation, mating and parenting to language and culture.

Available*online[<http://ukcatalogue.oup.com/product/9780195101072.do#.UaSK96I3uoU>]*.

Barrett, L., R. Dunbar, and J. Lycett. 2002. *Human evolutionary psychology*. Palgrave.

Provides an excellent overview for students and researchers, rich in examples of studies using evolutionary approaches. Particularly useful for those interested in social behavior, and in understanding how approaches from behavioral ecology are used to address human behavior. Available*online[<http://www.palgrave.com/products/title.aspx?pid=257489>]*.

Buss, D. M., ed. 2005. *The handbook of evolutionary psychology*. Wiley.

Contains thirty-four articles ranging from key concepts in evolutionary psychology, popular areas of inquiry such as mating, parenting and group-living, and areas of interface with other areas of psychology. Available*online[<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471264032.html>]*.

Buss, D. M. 2012. *Evolutionary psychology: The new science of the mind*. 4th ed. Pearson.

Currently the most comprehensive textbook available; the 4th edition has been restructured and contains a rigorously updated coverage of recent studies.

Available*online[<http://www.pearsonhighered.com/educator/product/Evolutionary-Psychology-The-New-Science-of-the-Mind-4E/9780205015627.page>]*.

Crawford, C. and D. Krebs, eds. 2008. *Foundations of evolutionary psychology*. Taylor & Francis.

Twenty-four articles describing specific and general approaches within evolutionary psychology, from biological foundations through cognitive mechanisms and sex differences to aspects of prosocial and antisocial behavior.

Available*online[<http://www.taylorandfrancis.com/books/details/9780805859560/>]*.

Dunbar, R., L. Barrett, and J. Lycett. 2005. *Evolutionary Psychology: A beginner's guide*. Oneworld Publications.

An engaging, whistle-stop tour of evolutionary psychology aimed at those interested in an initial overview. Available*online[<http://www.oneworld-publications.com/pbooks/evolutionary-psychology-9781851683567>]*.

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Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Dunbar, R. I. M. and L. Barrett, eds. 2007. *The Oxford handbook of evolutionary psychology*. Oxford Univ. Press.

The handbook for a balanced review. Contains 46 articles covering philosophical issues, comparative approaches, neurobiology and cognition, development, mating and life history, sociality and cultural evolution. The latter section is useful for new developments, with nine articles including language, memes, religiosity and music, as well as theoretical approaches. Available*online[<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198568308.001.0001/oxfordhb-9780198568308>]*.

Workman, L. and W. Reader. 2008. *Evolutionary Psychology: An introduction*. 2nd ed. Cambridge Univ. Press.

A useful textbook, featuring case studies and guides for further reading. Covers core areas as well as areas such as emotion and psychopathy.

Available*online[http://www.cambridge.org/gb/knowledge/item1168990/?site_locale=en_GB]*.

JOURNALS

Of the few specialist journals, ***Evolution and Human Behavior*** is probably best-known, closely followed by ***Evolutionary Psychology***. Others are ***Journal of Evolutionary Psychology***, ***Journal of Social, Evolutionary and Cultural Psychology***, ***Human Nature***, and ***Human Ethology Bulletin***. Papers are also published in general psychological journals, such as ***Psychological Science***. Papers with a more biological outlook, or those that address theoretical issues in humans which are also of interest to biologists, are published in other journals, such as ***Proceedings of the Royal Society B***.

**Evolution and Human Behavior*[<http://www.sciencedirect.com/science/journal/10905138>]*

This is the journal of the *Human Behavior and Evolution Society[<http://www.hbes.com/>]*, and is the specialist journal with the highest profile. Until 1996, it was published under the title '*Ethology and Sociobiology*'. Contains mainly empirical articles, with some theoretical papers.

**Evolutionary Psychology*[<http://www.epjournal.net/>]*

An online open-access journal (unusually for an open-access journal, it also charges no publication fees to authors). Is establishing itself as a close rival to *Evolution and Human Behavior*. Contains both empirical and theoretical papers. Not to be confused with *Journal of Evolutionary Psychology*

**Human Ethology Bulletin*[http://media.anthro.univie.ac.at/ishe_journal/index.php/heb]*

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The journal of the *International Society for Human Ethology[<http://www.ishe.org/>]*. Evolutionary in approach, with a particular emphasis on observational approaches to studying behavior. Previously a society newsletter, it was relaunched as a peer-reviewed journal in 2012.

*Human

Nature[<http://www.springer.com/social+sciences/anthropology+%26+archaeology/journal/12110>]*

An interdisciplinary journal drawing on evolutionary, biological, and sociological processes influencing human behavior. Papers using anthropological insights and those exploring impacts on science and society are often found here.

Journal of Evolutionary Psychology[<http://akademiai.com/content/120852/>]

Not to be confused with *Evolutionary Psychology*. Publishes theoretical and empirical papers from all relevant disciplines, including psychology, anthropology, and human behavioral ecology.

Journal of Social, Evolutionary and Cultural Psychology[<http://shell.newpaltz.edu/jsec/>]

Affiliated to the NorthEastern Evolutionary Psychology Society. Publishes theoretical and empirical papers in all areas of evolutionary psychology, but emphasizes papers dealing with real-world applications and cultural evolution.

Proceedings of the Royal Society B[<http://rspb.royalsocietypublishing.org/>]

Published by the Royal Society, the UK's leading scientific academy, 'Proceedings B' publishes papers in the biological sciences, including those dealing with human behavior providing these are underpinned by a firm biological basis or theoretical background.

Psychological Science[<http://pss.sagepub.com/>]

Leading empirical psychology journal, in which papers featuring evolutionary perspectives are becoming increasingly frequent.

FOUNDATIONS IN EVOLUTIONARY THEORY

Evolutionary psychology as a discipline is underpinned by basic evolutionary theory. Obviously, *The Origin of Species* is a starting point (Darwin 1998), in which the theory of evolution by natural selection is first set out. Close behind this is Darwin 2004 which engages more directly with human evolution and introduces the influential idea of sexual selection. Wilson 2000 is influential, too, merging contemporary knowledge of evolution, ecology and social behavior in animals, with a final chapter on humans which also proved controversial at the time. Dawkins 2006 provides an exposition of the gene-centred view of evolution, which was influenced by work such as the classic work,

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Hamilton 1964, on kin selection. Wilson and Sober 1994 has since argued that group selection, as opposed to only gene or individual level selection, can occur where individuals have higher fitness by virtue of their group membership. Tinbergen 1963 describes four levels of explanation for behavior, which are useful for distinguishing between different approaches when describing specific behaviors.

Darwin, C. 1998. *The origin of species*. Penguin Books.

Originally published in 1859. This is the book which describes Darwin's theory of evolution by natural selection, which lays the foundation for all evolutionary research and thinking since. Available*online[http://www.penguinclassics.co.uk/nf/Book/BookDisplay/0,,9780141907741,0,0.html?The-Origin_of_Species_by_Means_of_Natural_Selection_Charles_Darwin]*.

Darwin, C. 2004. *The descent of man, and selection in relation to sex*. Penguin Books.

Originally published in 1871. Here Darwin develops his theory to address human evolution, and introduces his second great idea, sexual selection. As with *Origin*, this was controversial at the time; both books are incomparably influential.

Available*online[http://www.penguinclassics.co.uk/nf/Book/BookDisplay/0,,9780140436310,0,0.html?The_Descent_of_Man_Charles_Darwin]*.

Dawkins, R. 2006. *The selfish gene*. Oxford University Press.

Originally published in 1975. Accessible and engaging book which has proved highly influential. It describes the 'gene's eye view' of evolution, describing the unit of selection as genes, not individuals, where individuals are merely 'vehicles' for the gene. The 30th anniversary edition contains a new introduction by the author.

Available*online[<http://ukcatalogue.oup.com/product/9780199291151.do#.UaTJ5ql3uoV>]*.

Hamilton, W. D. 2005. *Narrow roads of gene land – the collected papers of W.D. Hamilton. Volume 1: Evolution of social behaviour*.

A collection of Hamilton's papers on evolution of social behaviour, some of the most famous papers in the field. Each paper is preceded by a commentary by the author, providing an interesting autobiographical and historical context to his thinking.

Available*online[<http://ukcatalogue.oup.com/product/9780716745303.do>]*.

Tinbergen, N. 1963. On aims and methods of ethology. *Zeitschrift für Tierpsychologie* 20: 410-433.

[DOI: 10.1111/j.1439-0310.1963.tb01161.x]

Sets out different approaches to elucidate the evolutionary origins of specific behaviors or traits, namely descriptions of development, causation, function and phylogeny; useful in showing how approaches by evolutionary psychologists (who might be primarily describing

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behavior in functional terms) are complementary to, say, neuroscientists, who are primarily interested in causation.

Wilson, D. and E. Sober. 1994. Reintroducing group selection to the human behavioral sciences. *Behavioral and Brain Sciences* 17: 585–654. [DOI: 10.1017/S0140525X00036104]

Introduces multi-level selection theory, which proposes that selection can occur at the level of the group providing certain conditions are met, as well as at the individual level.

Wilson, E. O. 2000. *Sociobiology: The new synthesis*. Harvard University Press.

Originally published in 1975, when it was hailed as one of the most important books on animal behavior, but it was the final chapter, on humans (p. 547-575), that spawned vitriolic attacks.

Nonetheless, this laid the groundwork for evolutionary psychology to develop. The 25th anniversary edition includes a retrospective by the author.

Available*online[<http://www.hup.harvard.edu/catalog.php?isbn=9780674002357>*].

APPROACHES IN EVOLUTIONARY PSYCHOLOGY

Tooby and Cosmides 1992 introduce the basis for evolutionary psychology in this seminal paper, distinguishing the evolutionary approach from the standard social science model. Buss 1995 fleshes this out, describing the adaptive solutions to recurrent challenges faced by our human ancestors. These ideas are based on the proposal that these challenges were posed by the environment in which early humans evolved, known as the environment of evolutionary adaptedness (or EEA, after Bowlby 1969; note that this concept is controversial, see *Criticisms and defense of evolutionary psychology*). They also suggest that the adaptive solutions to each of these challenges in the EEA involve multiple domain-specific brain cognitive mechanisms, or *modules*, a view that has been described as the ‘massive modularity’ hypothesis; a detailed explanation of these concepts is presented in Barrett and Kurzban 2006. These ideas form the basis for what has been described as ‘narrow sense’ evolutionary psychology (e.g. Buller and Hardcastle 2000), in contrast to a broader field of enquiry for which the aim is to simply interpret human behavior from an evolutionary perspective. As Barrett et al. 2002 explains, evolutionary psychology in this broader sense is conducted by researchers who do not subscribe strictly to the theoretical basis proposed by the likes of Tooby, Cosmides and Buss; instead, they tend to either argue instead that domain-general mechanisms arising from plasticity in the brain during development are sufficient to explain behavioral complexity (see *Criticisms and defense of evolutionary psychology*), or prefer to remain agnostic about cognitive mechanisms and work instead within frameworks used by animal behavioral ecologists which address consequences of behavior on functional outcomes such as reproductive success. McElreath and Henrich 2007 reviews dual-inheritance theory, another approach used by those interested in cultural evolution, which interprets behavior as the outcome of an interaction

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between genetic and cultural evolution. An insightful comparison of the strengths and shortfalls of, and interactions between, all these various different approaches is found in Laland and Brown 2011.

Barrett, H. C. and R. Kurzban. 2006. Modularity in cognition: Framing the debate. *Psychological Review* 113: 628–647. [DOI: 10.1037/0033-295X.113.3.628]

A robust defence of modularity, dealing with critiques that have been levelled against it. Focusing on cognitive architecture, development, genetics, and evolution. Excellent introduction to the issues in this contentious area.

Barrett, L., R. Dunbar, and J. Lycett. 2002. *Human evolutionary psychology*. Palgrave.

Presents a comparison of different paradigms in studies of human evolutionary psychology, including a well-articulated distinction between approaches based on behavioral ecology and evolutionary cognitive psychology.

Available*online[<http://www.palgrave.com/products/title.aspx?pid=257489>]*.

Bowlby, J. 1969. *Attachment*. Basic Books.

In his influential book, Bowlby suggests that attachment between toddlers and mothers arises out of evolutionary benefits from close bonding in early humans, in an environment of evolutionary adaptedness (EEA), which he pictured as resembling present-day hunter-gatherer societies. This has since become a core idea in some views of evolutionary psychology, which suggest a mismatch between our current environment and that of the EEA.

Buller, D. J. and V. G. Hardcastle. 2000. Evolutionary Psychology, Meet Developmental Neurobiology: Against Promiscuous Modularity. *Brain and Mind* 1: 307–325.

[10.1023/A:1011573226794]

A critique of domain-specific reasoning in evolutionary psychology. The authors argue that the notion of massive modularity, as proposed by Tooby and Cosmides in particular, is unjustified and unsupported by evidence. They suggest instead that adaptive behaviors arise rather through learning during development and as a result of domain-general processes.

Buss, D. M. 1995. Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry* 6: 1–30. [DOI: 10.1207/s15327965pli0601]

An introduction to evolutionary psychology, outlining the agenda and approaches used by its proponents in comparison to other psychological sub-disciplines.

Laland, K. and G. Brown. 2011. *Sense and Nonsense: Evolutionary Perspectives on Human Behavior*. 2nd Edition. Oxford University Press.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

An engaging account of the ideas and methods underlying five different evolutionary approaches to the study of human behavior (sociobiology, human behavioral ecology, evolutionary psychology, cultural evolution, and gene-culture coevolution). Provides a pluralistic perspective and opportunity to contrast and assess different approaches.

Available*online[<http://ukcatalogue.oup.com/product/9780199586967.do#.UaUq9ql3uoU>]*.

McElreath, R. and J. Henrich. 2007. "Dual inheritance theory: the evolution of human cultural capacities and cultural evolution". In *The Oxford Handbook of Evolutionary Psychology*. Edited by R. I. M. Dunbar and L. Barrett, 555-570. Oxford University Press.

Reviews evidence for cultural learning and gene-culture coevolution, and argues that full understanding of human behavior necessitates, as well as genetic transmission, the consideration of cultural evolution as a second inheritance system.

Available*online[<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198568308.001.0001/oxfordhb-9780198568308>]*.

Tooby, J. and L. Cosmides. 1992. "The psychological foundations of culture". In *The adapted mind: Evolutionary psychology and the generation of culture*. Edited by J. H. Barkow, L. Cosmides, and J. Tooby, 19–136. Oxford University Press.

A detailed exposition of the evolutionary psychology approach to human culture and psychology, contrasted against the standard social science model. A classic paper which continues to inform research by many evolutionary psychologists today.

Available*online[<http://ukcatalogue.oup.com/product/9780195101072.do#.UaSK96l3uoU>]*.

CRITICISMS AND DEFENSE OF EVOLUTIONARY PSYCHOLOGY

A variety of criticisms have been launched against evolutionary psychology as an approach to understanding human behavior. Aside from accusations that evolutionary psychologists argue for genetic determinism (i.e. that they consider environmental, including social, influences to be unimportant in shaping behaviour) and that they commit the 'naturalistic fallacy' (believing that whatever is natural, is good), both of which are based on misconceptions about what the overwhelming majority of evolutionary psychologists actually think, there are several more incisive and informed critiques (in what follows in this section, readers may wish to refer to *Approaches in Evolutionary Psychology* for explanation of terms and concepts). Samuels 1998 and Davies et al. 1995 provide early critiques of the massive modularity concept proposed by Tooby, Cosmides and others. Irons 1998 questions the validity of the concept of the EEA (environment of evolutionary adaptedness) and an associated set of evolved modules, both key ideas in narrow-sense evolutionary psychology. Panksepp and Panksepp 2000 and Buller 2005 address these and other criticisms and provide alternative interpretations. Other general criticisms launched against both narrow and broad sense evolutionary psychology are that interpretations of apparently adaptive behavior are riddled by

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post-hoc story-telling (and that hypotheses are untestable, e.g. Schlinger 1996). Confer et al. 2010 provides a robust rebuttal of these criticisms. Finally, Henrich et al. 2010 addresses ethnocentrism in psychological research in general, a criticism that can be equally, perhaps especially, levelled at evolutionary psychology. The authors' criticism, that the majority of empirical research stems from an unrepresentative sample of the world's population, is undeniably accurate, and addressing it will no doubt be a key feature of research effort in the near future.

Buller, D. J. 2005. Evolutionary psychology: the emperor's new paradigm. *Trends in Cognitive Sciences* 9: 277-83.

Critiques some central claims of evolutionary psychology research (e.g. cheater-detection modules and evolved sex differences in jealousy), arguing they are more parsimoniously explained by, respectively, a non-modular mind employing general logical principles and by sex-specific learned beliefs about likelihood and consequences of mate desertion.

Confer, J. C., J. A. Easton, D. S. Fleischman, C. D. Goetz, D. M. G. Lewis, C. Perilloux, C, and D. M. Buss. 2010. Evolutionary psychology: Controversies, questions, prospects, and limitations. *American Psychologist* 65: 110–126. [doi:10.1037/a0018413]

A robust defense of several common criticisms of evolutionary psychology research. A useful paper, although critics may remain unconvinced by the rebuttal of domain-general arguments.

Davies, P. S, J. H. Fetzer, and T. R. Foster. 1995. Logical reasoning and domain specificity. *Biology and Philosophy* 10: 1–37. [DOI:10.1007/BF00851985]

Criticizes several ideas central to narrow-sense evolutionary psychology (see *Approaches in evolutionary psychology*), including the perceived over-reliance on the Wason selection task, a key methodology used by Tooby and Cosmides, as well as flaws in their use and interpretation of results on the task.

Henrich, J., Heine, S. J., and Norenzayan, A. 2010. The weirdest people in the world? *Behavioral and Brain Sciences* 33: 61-83. [DOI: 10.1017/S0140525X0999152X]

A critique of psychological (not just evolutionary psychological) research, showing that most empirical studies are based on WEIRD (Western, Educated, Industrialised, Rich and Democratic) societies. Argues against generalising from these studies to claims about universal human psychological functioning and proposes ways to reorganise research to avoid this pitfall.

Irons, W. 1998. Adaptively relevant environments versus the environment of evolutionary adaptedness. *Evolutionary Anthropology* 6: 194-204. [DOI: 10.1002/(SICI)1520-6505(1998)6:6<194::AID-EVAN2>3.0.CO;2-B]

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Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Critiques the concept of the Environment of Evolutionary Adaptedness (EEA, see *Approaches in Evolutionary Psychology*), a central tenet of narrow-sense evolutionary psychology. Proposes instead that a succession of environmental change may alter some cognitive adaptations but not others, resulting in a mosaic of influence and response.

Panksepp, J. and J. B. Panksepp. 2000. The seven sins of evolutionary psychology. *Evolution and Cognition* 6: 108-131.

A critical but balanced critique of approaches in (especially narrow-sense) evolutionary psychology research. For each of seven 'sins', alternative views or interpretations from neurobiology and evolutionary biology are proposed.

Samuels, R. 1998. Evolutionary psychology and the massive modularity hypothesis. *British Journal for the Philosophy of Science* 49: 575–602. [DOI:10.1093/bjps/49.4.575]

Argues that massive modularity is not necessary to describe flexibility in cognitive processing, that empirical support for it is slim, and that other models are at least equally useful.

Schlinger, H. D. 1996. How the human got its spots: A critical analysis of the just so stories of evolutionary psychology. *Skeptic* 4: 68-76.

One example of a critique of adaptive story-telling in evolutionary psychology, its title inspired by Rudyard Kipling's famous book.

DEVELOPMENT

Almost all behavior is either learned or conditional on stages of development. Understanding how a specific behavior develops is therefore essential in explaining any aspect of its mechanism and function. West-Eberhard 2003 is a comprehensive general overview, drawing on examples from the full range of taxa. Bjorklund and Hernández Blasi 2005 reviews evolutionary psychology approaches to child development. Spelke and Kinzler 2007 proposes that children are born with 'core knowledge' about the world, particularly in social contexts. Bjorklund and Sellers 2012 provides a recent review of child development within the context of the family, and Geary 2012 describes how evolutionary psychology holds insights for educational development. Evolutionary developmental models explain individual variation in responses to environmental influence; Ellis and Boyce 2008 outlines how plasticity develops in response to predicted future environments, and Belsky and Pluess 2009 argues for differential susceptibility to environment which is genetically based. Hagen and Hammerstein 2005 argues along similar lines, proposing that this results in robustness in the face of environmental uncertainty.

Belsky, J. and M. Pluess. 2009. Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin* 135: 885-908. [DOI: 10.1037/a0017376]

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Presents evidence for genetically-underpinned differential susceptibility, or plasticity, to environmental influences. In contrast to predictions from other models for variability in vulnerability to environmental adversity, the authors show that this variability also occurs in response to positive environmental influence, suggesting general plasticity in response to both positive and negative effects.

Bjorklund, D. F. and C. Hernández Blasi. 2005. "Evolutionary developmental psychology". In *The handbook of evolutionary psychology*. Edited by D. M. Buss, 828-850. Wiley.

Excellent introductory text outlining evolutionary perspectives in child development. A major contention is that selective pressures operate especially stringently on developmental processes, in infancy and childhood, and for parents, in investment in offspring.

Available*online[<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471264032.html>]*.

Bjorklund, D. F. and P. D. Sellers. 2012. "The evolved child: adapted to family life". In *Applied Evolutionary Psychology*. Edited by S. C. Roberts, 55-77. Oxford University Press.

Describes consequences of family life on child development, and on children's adaptations to social living in general, and family life in particular.

Ellis, B. J. and W. T. Boyce. 2008. Biological sensitivity to context. *Current Directions in Psychological Science* 17: 183-187. [DOI: 10.1111/j.1467-8721.2008.00571.x]

Describes an alternative model to Belsky and Pluess (2009) to account for plasticity in development, in which plasticity in stress-response systems are not genetically underpinned but develop in anticipation of environmental adversity. This can lead to highly-reactive response to both negative, stressful environments as well as positive, supportive ones.

Geary, D. C. 2012. "Application of evolutionary psychology to academic learning". In *Applied Evolutionary Psychology*. Edited by S. C. Roberts, 78-92. Oxford University Press.

Outlines evolutionary insights into educational psychology and evolved cognitive, developmental and motivational bases for learning, as well as ways in which evolutionary perspectives might be employed to promote motivation and learning during childhood.

Hagen, E. H. and P. Hammerstein. 2005. Evolutionary biology and the strategic view of ontogeny: genetic strategies provide robustness and flexibility in the life course. *Research in Human Development* 2: 87-101. [DOI:10.1080/15427609.2005.9683346]

Argues that sensitivity of developmental trajectories in morphology, physiology and behavior are not explained by general plasticity, but rather by genetically coded strategies coupled with inherent conditionality, which together allows effective responses in a range of environmental circumstances.

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Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Spelke, E. S. and Kinzler, K. D. 2007. Core knowledge. *Developmental Science* 10: 89-96. [DOI: 10.1111/j.1467-7687.2007.00569.x]

Argues that infants possess core knowledge systems to represent objects, actions, number, and space, allowing early inferential reasoning about the world. Proposes evidence for a fifth – social partners – based on evidence such as attending more to people who speak the same language as their primary caregiver.

West-Eberhard, M. J. 2003. *Developmental plasticity and evolution*. Oxford University Press.

A must for those interested in mechanisms underpinning plasticity in development, and how these relate to adaptive evolution and evolutionary change. Thirty-one chapters covering findings from across disciplines.

THE SELF AND GROUP-LIVING

Humans are a social species and understanding how we manage social relationships and solve problems resulting from the actions of other individuals, either within groups or between groups, is a critical component of evolutionary psychology research. These concerns are particularly relevant in terms of the dynamics of cooperation between individuals and groups.

Individual Differences

Groups are obviously composed of individuals, with inherently selfish interests (Dawkins 2006). Geary 2009 provides a comprehensive review of human sex differences in evolutionary perspective. Wilson 1994 provides an early treatment of genetic influence on individual differences. Wilson 1998 and Buss and Greiling 1999 review approaches applying adaptive thinking to individual differences. Nettle 2006 reviews evolutionary bases of personality variation. Bouchard and Loehlin 2001 reviews evidence from behavior genetics research for differences in personality and attitudes. Church 2010 addresses personality studies across cultures.

Bouchard, T. J. and Loehlin, J. C. 2001. Genes, evolution and personality. *Behavior Genetics* 31: 243-273. [DOI: 10.1023/A:1012294324713]

Reviews the evidence, but also argues that connecting behavior genetics with evolutionary psychology produces new insights and research avenues.

Buss, D. M. and H. Greiling. 1999. Adaptive individual differences. *Journal of Personality* 67: 209-243. [DOI: 10.1111/1467-6494.00053]

Reviews different sources of individual differences, such as environmentally influenced self-calibration, self-assessment of heritable quality, as well as nonadaptive and maladaptive sources. A second section reviews ways to test between competing ideas about the nature of

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individual differences. Finishes by reviewing how these differences can help to solve social challenges.

Church, A. T. 2010. Current perspectives in the study of personality across cultures. *Perspectives on Psychological Science* 5, 441-449. [DOI: 10.1177/1745691610375559]

Compares the evolutionary psychology perspective on personality studies across cultures with those from other psychological and anthropological approaches, and considers how these different perspectives interact and might be integrated.

Dawkins, R. 2006. *The selfish gene*. Oxford University Press.

Originally published in 1975. Accessible and engaging book which has proved highly influential in changing the way we view evolution. It argues how genes, not individuals, are the unit of selection.

Available*online[<http://ukcatalogue.oup.com/product/9780199291151.do#.UaTJ5ql3uoV>]*.

Geary, D. C. 2009. *Male, Female: the evolution of human sex differences*. 2nd Edition. American Psychological Association.

Convincing review of how sexual selection leads to a variety of sex differences, ranging from parental investment, mating, emotionality, and cognition to psychiatric conditions and occupational choice. Available*online[<http://psycnet.apa.org/books/10370>]*.

Nettle, D. 2006. The evolution of personality variation in humans and other animals. *American Psychologist* 61: 622-631. [DOI: 10.1037/0003-066X.61.6.622]

Nettle argues that personality dimensions represent the outcome of selection acting on costs and benefits, with variation being maintained because no one dimension is unconditionally optimal.

Wilson, D. S. 1994. Adaptive genetic variation and human evolutionary psychology. *Ethology and Sociobiology* 15: 219-235. [DOI: 10.1016/0162-3095(94)90015-9]

Critiques work by some evolutionary psychologists who underestimate the importance of heritable variation on individual differences. Argues that a combination of genetic variation and phenotypic plasticity will be favoured by natural selection.

Wilson, D. S. 1998. Adaptive individual differences within single populations. *Philosophical Transactions of the Royal Society B* 353: 199-205. [DOI: 10.1098/rstb.1998.0202]

Charts historical approaches to describing individual phenotypic differences, arguing that evolutionary approaches explains findings from a broad range of fields, from evolutionary biology to social psychology.

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Social Cognition

Social cognition refers to the cognitive processes (storing, retrieving and processing information in the brain) involved in interactions with other individuals. Cosmides 1989 describes tests using the Wason selection task, a key idea in narrow-sense evolutionary psychology (see *Approaches in evolutionary psychology*). Neuberg et al. 2010 provides a useful introduction to evolutionary perspectives on standard approaches to social psychology. Effective management of social relationships requires understanding of others' points of view (theory of mind) which is comprehensively reviewed in Brune and Brune-Cohrs 2006. Todorov et al. 2011 reviews neural underpinnings and functional outcomes of social cognition, and Dunbar 1998 outlines the social brain hypothesis for patterns of encephalisation across taxa and for disproportionate neocortical size in social primates and particularly humans. Neuberg and Cottrell 2008 and Schaller et al. 2007 deal in more depth with specific problems that arise from group-living in humans and present views on adaptive solutions. Dunbar et al. 2010 presents a very broad overview of sociality and psychology, combining evolutionary and other perspectives.

Brune, M., and U. Brune-Cohrs. 2006. Theory of mind – evolution, ontogeny, brain mechanisms and psychopathology. *Neuroscience and Biobehavioral Reviews* 30: 437-455. [DOI]: 10.1016/j.neubiorev.2005.08.001]

A wide-ranging review of research on evolutionary contribution to understanding of theory of mind, its development and neural underpinnings, and how this research informs and is informed by psychopathological conditions.

Cosmides, L. 1989. The logic of social exchange: has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition* 31: 187-276.

Describes tests of social exchange theory, in which social stability and interaction are governed by negotiated exchange between social partners, to their mutual benefit. Performance on these tasks is argued to support rational reasoning in social problem-solving, and the existence of specialised cognitive modules that facilitate solutions to social problems.

Dunbar, R., C. Gamble, and J. Gowlett, eds. 2010. Social brain, distributed mind. Oxford University Press/British Academy.

An edited volume with 22 chapters, integrating evolutionary psychology perspectives with those from archaeology, philosophy, sociology and cognitive science to map the time course of human cultural evolution, including changes in language, technology, and music, as well as describing social processes from ancestral small groups to modern large communities.

Available*online[<http://ukcatalogue.oup.com/product/9780197264522.do#.UaZONDl3uoU>*].

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Dunbar, R. I. M. 1998. The social brain hypothesis. *Evolutionary Anthropology* 6: 178-190. [DOI: 10.1002/(SICI)1520-6505(1998)6:5<178::AID-EVAN5>3.0.CO;2-8]

Argues that selection on brain size may be more sensitive to social processing need than to ecological information. Extrapolates from data on neocortex ratio, particularly in primates, to make the assertion that the 'natural' human group size is 150 – what has since become known as Dunbar's number.

Neuberg, S. L. and C. A. Cottrell. 2008. Managing the threats and opportunities afforded by human sociality. *Group Dynamics* 21: 63-72. [DOI: 10.1037/1089-2699.12.1.63]

Reviews evolutionary perspectives on sociality and summarizes available evidence, focusing on how people choose with whom to interact, how people manage the impressions they make on others, threat management, and management of intra-group welfare relative to other groups.

Neuberg, S. L., D. T. Kenrick, and M. Schaller. 2010. "Evolutionary social psychology". In *Handbook of Social Psychology*, 5th edition. Edited by S. T. Fiske, D. Gilbert, and G. Lindzey, 761-796. John Wiley & Sons.

A wide-ranging review of evolutionary approaches to social psychology; an excellent introduction to the differences and commonalities at the interface between evolutionary and standard social psychology.

Available*online[<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470137487.html>]*.

Schaller, M., J. H. Park, and D. T. Kenrick. 2007. "Human evolution and social cognition". In *The Oxford handbook of evolutionary psychology*. Edited by Dunbar, R. I. M., and L. Barrett, 491-504. Oxford University Press.

Reviews social cognition by identifying recurrent problems in social living, using cost-benefit approaches to identify plausible solutions, analysing how these solutions might be predicted to operate in modern social environments, and testing these predictions with empirical evidence.

Available*online[<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198568308.001.0001/oxfordhb-9780198568308>]*.

Todorov, A., S. T. Fiske, and D. A. Prentice, eds. 2011. *Social Neuroscience: Toward understanding the underpinnings of the social mind*. Oxford University Press.

An edited volume with 19 articles addressing recent advances in understanding the neural underpinnings of social processes. Includes sections on perception of other individuals, perception of intergroup interaction, self-regulation of social behavior and issues in social

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living. Available*online[

Cooperation and Reciprocity

Human societies are characterized by their cooperativeness. However, large size of social groups makes them susceptible to exploitation by free-riders (those who take the benefit without repayment). On the societal scale, this leads to the ‘Tragedy of the Commons’ (over-exploitation of communal resources: Hardin 1968). Economists and evolutionary researchers have argued about the stability of cooperation as a solution to social contract problems because Axelrod and Hamilton 1981 show that, in the short term, it always pays to be selfish and renege on the contract. Trivers 1971 proposed reciprocal altruism as one solution. Killingback et al. 2006 proposes a solution via group structuring. Nowak 2006 reviews competing ideas in a mathematical framework (for more information on kin selection, see *Kinship*). West et al. 2011 reviews misconceptions of ideas about the evolution of cooperation, particularly of evolutionary psychologists, and is an excellent starting place. Cosmides and Tooby 2005 outlines evidence for cognitive mechanisms for detection of free-riders. Bereczkei et al. 2010 is a neat example of empirical work by evolutionary psychologists in this area, revealing the social context in which cooperative decisions are often made.

Axelrod, R. and W. D. Hamilton. 1981. The evolution of cooperation. *Science* 211: 1390-1396. [DOI: [10.1126/science.7466396](https://doi.org/10.1126/science.7466396)]

Classic paper describing how cooperation between pairs of individuals can start and continue, based on the model of the Prisoner’s Dilemma game and results of a famous open tournament in which the winning strategy, tit-for-tat, was the winner.

Bereczkei, T., B. Birkas, and Z. Kerekes. 2010. Altruism towards strangers in need: costly signaling in an industrial society. *Evolution and Human Behavior* 31: 95-103. [DOI: [10.1016/j.evolhumbehav.2009.07.004](https://doi.org/10.1016/j.evolhumbehav.2009.07.004)]

Empirical study demonstrating conditionality in cooperative behavior. Individuals are more willing to offer support when this is done in the presence of others than when done in secret. The authors propose this supports the idea of ‘costly signaling’ – in which apparently altruistic behavior is rewarded by higher social recognition.

Cosmides, L. and J. Tooby. 2005. “Neurocognitive adaptations designed for social exchange”. In *The Handbook of Evolutionary Psychology*. Edited by D. M. Buss, 584-627. Wiley.

Reviews ideas for cognitive modules to coordinate the recurrent problem of detecting free-riders. A core idea and case study problem in narrow-sense evolutionary psychology.

Available*online[<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471264032.html>]*.

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Hardin, G. 1968. The Tragedy of the Commons. *Science* 162: 1243-1248. [DOI: 10.1126/science.162.3859.1243]

A prescient take on the problems of exhaustible resources, population expansion and inherently selfish and in-group biased human nature. His gloomy and distasteful conclusion is that the only way to solve the tragedy is to remove individual liberty in terms of family planning.

Nowak, M. A. 2006. Five Rules for the Evolution of Cooperation. *Science* 314: 1560–1563. [doi:10.1126/science.1133755]

Describes five prevalent explanations for the evolution of cooperation (kin selection, direct reciprocity, indirect reciprocity, network reciprocity, and group selection), defining simple mathematical rules for each. Suggests that we might add “natural cooperation” as a third fundamental principle of evolution, alongside mutation and natural selection.

Trivers, R. L. 1971. The evolution of reciprocal altruism. *Quarterly Review of Biology* 46: 35-57. [doi:10.1086/406755]

A classic paper in evolutionary biology describing how selection can favour cooperation despite the existence of free-riders in the population.

West, S. A., C. El Mouden, and A. Gardner. 2011. Sixteen common misconceptions about the evolution of cooperation in humans. *Evolution and Human Behavior* 32: 231–262.

[doi:10.1016/j.evolhumbehav.2010.08.001]

Provides an accessible overview of social evolution theory and the evolutionary work on cooperation, emphasising common misconceptions. Good starting place for researchers interested in evolutionary psychology approaches to studying cooperation, including a helpful diagram (their Fig. 2) of the hierarchy and inter-relatedness between different explanations for cooperative behavior.

Killingback, T., J. Bieri, and T. Flatt. 2006. Evolution in group-structured populations can resolve the tragedy of the commons. *Proceedings of the Royal Society B* 273: 1477-1481. [DOI: 10.1098/rspb.2006.3476]

Proposes a simple mechanism based on population dynamics for the emergence and maintenance of cooperation, which requires neither cognitive ability nor other explanations such as kin selection, direct or indirect reciprocity, punishment, optional participation and trait-group selection.

Kinship

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Hamilton 2005 provides the classic papers in his theory of kin selection, in which organisms demonstrate tendencies to favour relatives at the expense of less closely related individuals, is a leading idea in the evolution and maintenance of cooperation (for other ideas, see *Cooperation and Reciprocity*). Although this idea has dominated thinking in evolutionary biology and psychology ever since, it was controversially challenged by Nowak et al. 2010, leading to stinging rebuttals by a host of leading evolutionary thinkers, such as in Abbot et al. 2011 and Bourke 2011. Kinship also plays a part in mating preferences. Rantala and Marcinkowska 2011 discuss how close interaction during childhood subsequently leads to strong sexual aversion at maturity. Lieberman et al. 2007 proposes a model for how the brain regulates prosocial behavior towards kin while directing mating interest away. DeBruine et al. 2011 demonstrates how these mechanisms can also influence behavior towards non-kin who share physical characteristics in common with kin. Madsen et al. 2007 provide an experimental demonstration of kin-directed altruism.

Abbot, P., et al. 2011. Inclusive fitness theory and eusociality. *Nature* 471: E1–E4. [DOI: 10.1038/nature09831]

A vigorous response, from an A-Z of leading evolutionary thinkers, to Nowak et al. 2010. The authors argue that Nowak et al. misunderstand relevant theory and misrepresent the literature, and that the only prediction generated by their model is in line with inclusive fitness theory.

Bourke, A. F. G. 2011. The validity and value of inclusive fitness theory. *Proceedings of the Royal Society B* 278: 3313-3320. [DOI: 10.1098/rspb.2011.1465]

A more detailed response to Nowak et al. 2010 from a leading researcher in social insects, concluding, like Abbot et al. 2011, that inclusive fitness theory is alive and well.

DeBruine, L. M., B. C. Jones, C. D. Watkins, S. C. Roberts, A. C. Little, F. G. Smith, and M. C. Quist. 2011. Opposite-sex siblings decrease attraction, but not prosocial attributions, to self-resembling opposite-sex faces. *Proceedings of the National Academy of Sciences USA* 108: 11710-11714. [DOI: 10.1073/pnas.1105919108]

An experimental demonstration, using responses to digitally manipulated facial images, that contextual cues of kinship influence kin-recognition mechanisms even in unfamiliar individuals in the absence of these contextual cues. Shows functional dissociation between mechanisms regulating inbreeding avoidance and those regulating prosocial behavior towards kin.

Hamilton, W. D. 2005. *Narrow roads of gene land – the collected papers of W.D. Hamilton. Volume 1: Evolution of social behaviour.*

This collection of papers includes Hamilton's two classic papers on genetical evolution of social behaviour, which describes and provides a formal model for inclusive fitness: how

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individuals can increase their own fitness by helping relatives, with whom they share genes in common, to survive and reproduce.

Available*online [<http://ukcatalogue.oup.com/product/9780716745303.do>]*.

Lieberman, D. J. Tooby, and L. Cosmides (2007). The architecture of human kin detection. *Nature* 445: 727-731. [doi:10.1038/nature05510]

Presents a model for cognitive processes underlying kin recognition in order to direct prosocial behavior towards kin, and to deflect attraction towards kin. Includes an empirical study measuring proposed regulatory mechanisms, namely perinatal association with the individual's biological mother and the duration of sibling coresidence.

Madsen, E. A., R. J. Tunney, G. Fieldman, H. C. Plotkin, R. I. M. Dunbar, J-M. Richardson, and D. McFarland. 2007. Kinship and altruism: A cross-cultural experimental study. *British Journal of Psychology* 98: 175-359. [DOI:10.1348/000712606X129213]

Experimental demonstration of Hamilton's rule in humans, showing (in the UK and South Africa) that people behave in accordance with Hamilton's rule by acting more altruistically towards more closely related individuals. Provides the first unequivocal experimental evidence that kinship plays a role in moderating altruistic behavior.

Nowak, M. A., C. E. Tarnita, and E. O. Wilson. 2010. The evolution of eusociality. *Nature* 466: 1057-1062. [DOI: doi:10.1038/nature09205]

A controversial challenge to the idea that kin selection, via inclusive fitness, leads to eusociality, suggesting instead that it can be explained more simply by natural selection and structuring of populations. Although focused on eusocial animals, they finish by raising the potential for implications for ideas about human sociality.

Rantala, M. J. and U. M. Marcinkowska. 2011. The role of sexual imprinting and the Westermarck effect in mate choice in humans. *Behavioral Ecology and Sociobiology* 65: 859–873.

[DOI 10.1007/s00265-011-1145-y]

Presents a review of imprinting-like mechanisms and kin-aversion mechanisms and how these influence human mate preference.

MATING

As in the animal literature, interest in human mate choice is a dynamic and popular area of research inquiry. What factors and fitness considerations underpin attractiveness judgments, and therefore mate preferences and ultimately, mate choice? And how do these processes depend on genetic variation, environmental circumstances, and individual's current condition? These two questions are tackled, respectively, in the next two sections.

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General Principles

Buss and Schmitt 1993 sets the scene for evolutionary investigations into human mating psychology, while Gangestad and Simpson 2000 extends this and consider how mating strategies are sensitive to context and opportunity. Buston and Emlen 2003 is a study testing relative importance of several different general decision rules in guiding decision-making. Miller 2001 is a popular book describing evidence for sexual selection on the human brain and mind. Gangestad and Scheyd 2005 reviews theory and empirical studies of physical attractiveness, while Havlicek and Roberts 2009 reviews evidence for genetic influence on these judgments at the best studied gene region involved in mate choice. Gangestad and Thornhill 2008 reviews evidence for influence of women's menstrual cycle on male and female sexual behavior. DeBruine et al. 2006 shows how lab-measured preferences are valid proxies for studies of preference beyond the lab.

Buss D. M. and D. P. Schmitt. 1993. Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review* 100: 204-232. [DOI: 10.1037/0033-295X.100.2.204]

An influential review setting out the evolutionary basis for human mating strategies in men and women and approaches for studying them. It describes nine key hypotheses and reviews evidence relating to 22 predictions generated by these hypotheses, showing that the evolutionary approach is both testable and powerful.

Buston, P. M. and S. T. Emlen. 2003. Cognitive processes underlying human mate choice: the relationship between self-perception and mate preference in Western society. *Proceedings of the National Academy of Sciences USA* 100: 8805-8810. [DOI: 10.1073/pnas.1533220100]

An example of a large questionnaire study of mate preferences, testing between 'opposites attract', 'reproductive potentials attract' and 'like attracts like' decision rules. The authors conclude that the latter best explains general patterns of mating preference.

DeBruine L. M., B. C. Jones, A. C. Little, L. G. Boothroyd, D. I. Perrett, I. S. Penton-Voak, P. A. Cooper, L. Penke, D. R. Feinberg, and B. P. Tiddeman. 2006. Correlated preferences for facial masculinity and ideal or actual partner's masculinity. *Proceedings of the Royal Society B* 273: 1355-1360. (doi:10.1098/rspb.2005.3445)

This paper is important because it shows that measured preferences in the laboratory correlates with ideal or actual partner traits, providing evidence for the link between preference and choice.

Gangestad S. W. and G. J. Scheyd. 2005. The evolution of human physical attractiveness. *Annual Review of Anthropology* 34: 523-548. [doi:10.1146/annurev.anthro.33.070203.143733]

Full citation:

Roberts SC. 2014. Evolutionary Psychology. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

A comprehensive review of physical traits underpinning attractiveness judgments, and their biological value in terms of indicating likely paternal care and heritable benefits that these traits reveal.

Gangestad S. W. and J. A. Simpson. 2000. The evolution of human mating: trade-offs and strategic pluralism. *Behavioral and Brain Sciences* 23: 573–644. (doi:10.1017/S0140525X0000337X)

Describes links and trade-offs between allocation of reproductive effort towards mating and parental care, how these differ between men and women, and how this leads to conditional strategies in terms of short-term and long-term mating.

Gangestad, S. W. and R. Thornhill. 2008. Human oestrus. *Proceedings of the Royal Society B* 275: 991-1000. [DOI: 10.1098/rspb.2007.1425].

This paper reviews evidence for behavioral changes associated with changes in fertility across women's menstrual cycle, for both men and women. Interesting in their own right, these changes are also insightful in explaining general processes underpinning mating strategies.

Havlicek, J. and S. C. Roberts. 2009. MHC-correlated mate choice in humans: a review.

Psychoneuroendocrinology 34: 497-512. [DOI: 10.1016/j.psyneuen.2008.10.007]

Reviews evidence for influence of genotype at the major histocompatibility complex (MHC) on mate preference and choice. As in animals, MHC-type influences attractiveness directly and also regulates individual variation in preference, and potentially reproductive outcome, based on compatibility between partners.

Miller, G. 2001. *The mating mind: How sexual choice shaped the evolution of human nature*. Vintage Books.

A popular science book which proposes that sexual selection has shaped the human brain and mind, including the idea that preferences for intelligence and creativity in partners may be a partial explanation for evolution of large human brains and sex differences in behavior.

Available*online[<http://www.vintage-books.co.uk/books/0099288249/geoffrey-miller/the-mating-mind-how-sexual-choice-shaped-the-evolution-of-human-nature/>]*.

Variability in Preference and Choice

Nested within the general principles that appear to drive species-typical mate choices, there is considerable variation and plasticity. Little and Perrett 2002 describes some of this research in the context of facial preferences, and Roberts and Little 2008 reviews how these general principles can be integrated with evidence documenting condition-dependence on preference and effects of genetic compatibility between partners. Verweij et al. 2012 shows using twin studies that general preferences

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are at least partly heritable. DeBruine et al. 2010 shows that women's preferences are expressed with sensitivity to costs and benefits of preferred traits relative to the current environment, and Penton-Voak et al. 1999 that they are influenced by conception probability. Jones et al. 2007 demonstrates social influence on mate preferences. Beyond the lab, Roberts et al. 2012 tests effects of genetic and hormonal influences on choice on real-world choices and relationship outcomes, while Pawlowski and Dunbar 1999 shows how real-world preference expression is sensitive to market forces.

DeBruine L. M., B. C. Jones, J. R. Crawford, L. M. Welling, and A. C. Little. 2010. The health of a nation predicts their mate preferences: cross-cultural variation in women's preferences for masculinized male faces. *Proceedings of the Royal Society B* 277: 2405-2410. [DOI: 10.1098/rspb.2009.2184]

An example of how general principles guiding mate choice are sensitive to variation in environmental context, specifically how women's preference for male indicator traits of relative paternal investment and offspring health are facultatively influenced by environmental variation in disease risk.

Jones, B. C., L. M. DeBruine, A. C. Little, R. P. Burriss, and D. R. Feinberg. 2007. Social transmission of face preferences among humans. *Proceedings of the Royal Society of London B*, 274: 899-903. [doi:10.1098/rspb.2006.0205]

This paper shows that, like some animals, individuals can adjust their preferences between members of the opposite sex according to apparent interest and judgments of others, a phenomenon known as mate choice copying, or nonindependent mate choice.

Little, A. C. and D. I. Perrett. 2002. "Putting beauty back in the eye of the beholder[http://www.thepsychologist.org.uk/archive/archive_home.cfm/volumeID_15-editionID_76-ArticleID_352-getfile_getPDF/thepsychologist%5Clittle.pdf]". *The Psychologist* 15: 28-32.

An engaging and accessible overview of sources of individual variation in human attractiveness, describing effects of assortative preferences for facial traits and how these may reflect imprinting-like mechanisms in development of preferences, as well as condition- and state-dependent effects.

Pawlowski, B. and R. I. M. Dunbar. 1999. Impact of market value on human mate choice decisions. *Proceedings of the Royal Society B* 266, 281-285. [DOI: 10.1098/rspb.1999.0634]

This paper synthesises evolutionary concepts into a measure of relative mate value and tests how this influences expressed mate preference in the mating marketplace, using a personal ads database. A test of the evolutionary framework in a real-world setting.

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Penton-Voak, I. S., D. I. Perrett, D. L. Castles, T. Kobayashi, D. M. Burt, L. K. Murray, and R. Minamisawa. 1999. Menstrual cycle alters face preference. *Nature* 399: 741-742. [doi:10.1038/21557]

An influential paper showing how women's general preferences for masculine face shape are subtly altered based on their position within the menstrual cycle.

Roberts, S. C., K. Klapilová, A. C. Little, R. P. Burris, B. C. Jones, L. M. DeBruine, M. Petrie, and J. Havlíček. 2012. Relationship satisfaction and outcome in women who meet their partner while using oral contraception. *Proceedings of the Royal Society B* 279: 1430-1436. [DOI: 10.1098/rspb.2011.1647]

Brings together a suite of evolutionary perspectives and laboratory evidence on menstrual cycle shifts in preference, hormonal influence on preference, and the role of MHC in human mate choice, and tests the consequences of these effects for real-life partner choice, sexual attraction, and relationship outcome.

Roberts, S. C. and A. C. Little. 2008. Good genes, complementary genes and human mate choice. *Genetica* 134: 31-43. [DOI 10.1007/s10709-008-9254-x]

A synthesis of how general principles of human mate choice interact with individual traits to explain variation in human mate choice. In particular, it addresses how preferences for traits associated with 'good-genes' and 'compatible-genes' might be expected to be integrated in mate choice decision-making.

Verweij, K. J. H., A. V. Burri, and B. P. Zietsch. 2012. Evidence for genetic variation in human mate preferences for sexually dimorphic physical traits. *PLoS ONE* 7: e49294. [doi:10.1371/journal.pone.0049294]

Describes a test of preference for physical traits between and within twin pairs, with results showing significant heritability in some preferences.

PARENTING

Individual human children have a long period of dependency. As in animals, they benefit from as much care as they can solicit from parents, while the reproductive interests of parents extends not only to the current, but also future offspring. Trivers 1974 describes this problem as parent-offspring conflict. One consequence of this conflict, proposed in Trivers and Willard 1973 is that evolution may favour deviations from the population sex ratio conditional on parental condition: parents in good condition may be predicted to have more sons, while parents in poor condition may benefit from producing daughters. Krackow 1995 explores how plausible mechanisms underlying this effect in mammals are particularly complex compared to birds and reptiles, but Cameron et al. 2008 suggests that maternal glucose levels may provide a possible mechanism influencing offspring sex. This is further supported by Matthews et al. 2008 and their work on maternal diet around conception. These

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issues influence both reproductive decision-making and strategies of parental investment. The ethnographic literature suggests that women do not always produce the optimal number of children (in terms of maximising Darwinian fitness). Reproducing at the maximal rate ignores both the future impact of the costs of reproduction and the role that parental investment plays in maximising fitness. Humans can therefore be expected to adjust the number of offspring born depending on current socio-economic conditions and to adjust patterns of investment in children, in ways that serve to maximise fitness. This section addresses these issues separately, with literature heavily influenced by work of evolutionary anthropologists and human behavioral ecologists.

Cameron, E. Z., P. R. Lemons, P. W. Bateman, and N. C. Bennett. 2008. Experimental alteration of litter sex ratios in a mammal. *Proceedings of the Royal Society B* 275: 323-327.

Shows that maternal glucose level at conception influences sex litter ratios in laboratory mice, providing a mechanism for offspring sex adjustment.

Krackow, S. 1995. Potential mechanisms for sex-ratio adjustment in mammals and birds *Biological Reviews of the Cambridge Philosophical Society* 70: 225-241. [DOI: 10.1111/j.1469-185X.1995.tb01066.x]

Reviews possible mechanisms for sex ratio adjustment. Suggests that this could be influenced by gonadotropins and steroid hormones, which are known to be influenced by the kinds of ecological and condition-dependencies invoked in empirical studies of offspring sex ratios.

Mathews, F., P. J. Johnson, and A. Neil. 2008. You are what your mother eats: evidence for maternal preconception diet influencing foetal sex in humans. *Proceedings of the Royal Society B* 275: 1661-1668.

Compares diet of 740 British women who were unaware of their child's gender, finding a higher proportion of sons born to mothers who had high rates of energy intake and a higher proportion of daughters in the women with lowest intake.

Trivers, R. 1974. Parent-offspring conflict. *American Zoologist* 14: 249-264. [DOI: 10.1093/icb/14.1.249]

Another highly influential idea from Robert Trivers (see also *Cooperation and Reciprocity*), in which he describes the partly antagonistic individual interests of parents and offspring in terms of resource allocation. This idea provides the theoretical basis for the work described in the rest of this section.

Trivers, R. L. and D. E. Willard. 1973. Natural selection of parental ability to vary the sex ratio of offspring. *Science* 179: 90-92. [DOI: 10.1126/science.179.4068.90]

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

The paper describing the Trivers-Willard hypothesis for adaptive sex ratio variation. See *Parental Investment* for more information.

Reproductive decision-making

Voland 1998 and Lawson and Mace 2011 review evidence for optimization of reproductive decision-making in evolutionary perspective. Rogers 1990 and Mace 1996 model how this is also informed by economics and wealth. Blurton-Jones 1986 describes a case study of optimisation under ecological constraint. Betzig et al. 1998 provides a wealth of further examples and case studies. Against this background, Alvergne et al. 2013 describes conditions predicting adoption of contraceptive methods.

Alvergne, A., D. W. Lawson, P. M. Clarke, E. Gurmu, and R. Mace. 2013. Fertility, parental investment, and the early adoption of modern contraception in rural Ethiopia. *American Journal of Human Biology* 25: 107-115. [DOI: 10.1002/ajhb.22348]

Investigates uptake of modern hormonal contraception (70% injection, 30% oral contraception) in an agro-pastoralist community. Early adopters were more likely to be experiencing highest levels of offspring competition (women experiencing highest fertility and lowest child mortality), suggesting that individual effects trigger adoption of modern contraception early in the demographic transition.

Betzig, L., P. Turke, and M. Borgerhoff-Mulder, eds. 1998. *Human Reproductive Behaviour: a Darwinian Perspective*. Cambridge University Press.

A fascinating overview of studies from many different human societies. Twenty chapters from leading researchers, about half the book dealing with mating patterns and half with parenting issues.

Blurton-Jones, N. 1986. Bushman birth spacing: a test for optimal inter-birth intervals. *Ethology and Sociobiology* 7: 91-105. [DOI: 10.1016/0162-3095(86)90002-6]

This paper addresses an apparently maladaptive phenomenon – the extremely long inter-birth intervals in a southern African hunter-gatherer population. Demonstrates that observed and unique features of Bushman ecology mean that this interval is an optimal solution to the ecological constraints.

Lawson, D. W., and R. Mace. 2011. Parental investment and the optimization of human family size. *Philosophical Transactions of the Royal Society B* 366: 333-343. [DOI: 10.1098/rstb.2010.0297]

Reviews evidence for variation in fertility (offspring number) being explained by a life-history trade-off between reproductive rate and parental investment, in traditional and modern industrialized populations. Argues that the adaptive significance of modern reproductive

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behavior is understood in response to rising investment costs of rearing socially and economically competitive offspring.

Mace, R. 1996. When to have another baby: a dynamic model of reproductive decision-making and evidence from Gabra pastoralists. *Ethology and Sociobiology* 17: 263-274. [DOI: 10.1016/0162-3095(96)00044-1]

Develops an optimality model of reproductive decision-making in East African pastoralists, and tests this against observed data. Shows strategic trade-offs between number of children and dividing wealth so that each can marry and reproduce.

Rogers, A.R. 1990. Evolutionary economics of human reproduction. *Ethology and Sociobiology* 11: 479-496. [DOI: 10.1016/0162-3095(90)90022-X]

Presents an economic approach to reproductive decision-making, modelling the effect of heritable wealth, showing that optimal strategies depend on environmental richness, so as to maximize inherited wealth in poor environmental conditions, and to maximize offspring number in rich environments.

Voland, E. 1998. Evolutionary ecology of human reproduction. *Annual Review of Anthropology* 27: 347-374. [DOI: 10.1146/annurev.anthro.27.1.347]

An excellent overview and introduction to this topic. The author integrates life history theory with adaptive mechanisms regulating reproduction and reviews evidence relating to the ecology of fecundity, fertility, child-care strategies, and differential parental investment.

Parental Investment

Parental investment theory deals with the question of how males and females allocate resources towards parental care, in relation to the costs and benefits for each of doing so. Haig 1993 outlines how parent-offspring conflict is played out prenatally. Houston et al. 2005 presents theory and evidence for inter-parental conflict over care. Apicella and Marlow 2007 outlines evidence for facultative adjustment in paternal investment in humans. Almond and Edlund 2007 provides a test in humans of the Trivers-Willard hypothesis, for which Rickard et al. 2007 provides further evidence from consequences for subsequent siblings of having elder brothers. Daly and Wilson 1988 discusses the concept of discriminative parental solicitude, dividing parental care towards biological children over step-children and show how low investment in children may lead to severe consequences for step-children. Within the framework of parental investment, Lycett and Dunbar 1999 analyzes decisions about abortion – an ultimate disinvestment – and Brooks 2012 analyzes an extreme consequence played out on a population level.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Apicella, C. L. and F. W. Marlow. 2007. Men's reproductive investment decisions. *Human Nature* 18: 22-34. [DOI: 10.1007/BF02820844]

Examines variation in paternal investment in relation to the trade-off between mating and parenting. Provides evidence that men adjust paternal investment in relation to their perceived mate value (lower value men compensate by increasing investment).

Almond, D. and L. Edlund. 2007. Trivers-Willard at birth and one year: evidence from US natality data 1983–2001. *Proceedings of the Royal Society B* 274: 1624 2491-2496. [doi:10.1098/rspb.2007.0524]

A test of the Trivers-Willard hypothesis using data from 48 million births and 310,000 deaths among US white mothers. The proportion of sons was higher among married and better educated mothers, and there was a more male-biased mortality in unmarried, young mothers, providing support for the hypothesis.

Brooks, R. 2012. "Asia's missing women" as a problem in applied evolutionary psychology? *Evolutionary Psychology* 12: 910-925.

An interesting contemporary case study of the possible consequences of sex-biased parental investment, when taken to the extreme, in populations where males are culturally more 'valuable'.

Daly, M. and M. Wilson. 1988. Evolutionary psychology and family homicide. *Science* 242: 519-524. [DOI: 10.1126/science.3175672]

One of the classic papers in evolutionary psychology, demonstrating increased risk of violent death among non-kin, particularly for young children. The high cost, high effort enterprise of rearing children appears to be more easily endured for biological parents than step-parents.

Haig, D. 1993. Genetic conflicts in human pregnancy. *Quarterly Review of Biology* 68: 495–532. [doi:10.1086/418300]

A case study of how the partly opposing interests of mother and foetus, arising from parent-offspring conflict theory, plays out before birth. A fascinating paper with unparalleled physiological detail.

Lycett, J.E. and R. I. M. Dunbar. 1999. Abortion rates reflect the optimisation of parental investment strategies. *Proceedings of the Royal Society B* 266: 2355-2358. [DOI: 10.1098/rspb.1999.0931]

Analyzes an uncomfortable but potentially tractable case of parental investment decision-making, abortion, which runs counter to evolutionary expectations of maximizing reproductive fitness. Provides evidence that decisions about pregnancy termination are influenced by life history variables and current socioeconomic conditions, in a way that is reconcilable with considerations of fitness-enhancing behavior.

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Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Houston, A. I., T. Szekely, and J. M. McNamara. 2005. Conflict between parents over care. *Trends in Ecology & Evolution* 20: 33-38. [DOI: 10.1016/j.tree.2004.10.008]

A stimulating consideration of conflict between parents over investment in offspring. While offspring benefit from investment by both parents, each suffers a loss in future reproductive success through their own investment. Intriguing outcomes include patterns of negotiation and compensation, and that these depend on relative attractiveness of each parent.

Rickard, I. J., A. F. Russell, and V. Lummaa. 2007. Producing sons reduces lifetime reproductive success of subsequent offspring in pre-industrial Finns. *Proceedings of the Royal Society B* 274: 2981-2988. [doi:10.1098/rspb.2007.1051]

Provides the first evidence of a long-term intergenerational cost of reproduction in a long-lived species such as humans, where the cost of higher parental investment in male offspring is manifested in reduced reproductive success of subsequent siblings (there was no significant impact on survival).

CULTURAL EVOLUTION

Culture has been variously defined but most definitions include the notion that it encapsulates behaviors, beliefs and knowledge that is transmitted between individuals by aspects of social learning. In this sense it has become a hotbed of research in evolutionary psychology. Richerson and Boyd 2005 is an excellent overview, as is Pagel 2013. Whiten et al. 2011 provides a more concise introduction (as well as introducing a series of associated papers). McElreath and Henrich 2007 introduces dual inheritance theory, also known as gene-culture coevolution. O'Brien et al. 2010 deals with similarities between genes and individual cultural traits as discrete heritable units. Rendell et al. 2010 describes strategies for effective transmission and how social learning is critical. Caldwell and Millen 2008 describes cumulative cultural evolution, in which social learning with modification can lead to different cultural outcomes in separate transmission chains, along with some innovative methodological approaches for experimental research. Finally, Mace and Jordan 2011 reviews cultural diversity at the population level.

Richerson, P. J. and R. Boyd. 2005. *Not by genes alone: How culture transformed human evolution.* University of Chicago Press.

An accessible version of Richerson's and Boyd's ideas and an excellent introduction to the area. Their thesis is that cultural evolution is related to, but separate from, genetic evolution, and has a more rapid and influential effect on human society.

Available*online[<http://www.press.uchicago.edu/ucp/books/book/chicago/N/bo3615170.html>]*.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Caldwell, C. A. and A. E. Millen. 2008. Studying cumulative cultural evolution in the laboratory. *Philosophical Transactions of the Royal Society B* 363: 3529–3539. [doi:10.1098/rstb.2008.0133]

Excellent introduction to cumulative cultural evolution, and describes innovative approaches and methodologies for experimentally tests in the lab, including tasks of building the tallest towers using only spaghetti and modelling clay, or designing the furthest-flying paper aeroplanes. Transmission chains of learners modify design in experimental demonstrations of cumulative social transmission.

Mace, R. and F. M. Jordan. 2011. Macro-evolutionary studies of cultural diversity: a review of empirical studies of cultural transmission and cultural adaptation. *Philosophical Transactions of the Royal Society B* 366: 402-411. [DOI: 10.1098/rstb.2010.0238]

A review of macro-level cultural diversity in humans and efforts to test evolutionary hypotheses about behavioral and cultural diversity at this level.

McElreath, R. and J. Henrich. 2007. "Dual inheritance theory: the evolution of human cultural capacities and cultural evolution". In *The Oxford Handbook of Evolutionary Psychology*. Edited by R. I. M. Dunbar and L. Barrett, 555-570. Oxford University Press.

The authors introduce and discuss cultural evolution as a second inheritance system, alongside genetic transmission.

Available*online[<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198568308.001.0001/oxfordhb-9780198568308>]*.

O'Brien, M.J., R. L. Lyman, A. Mesoudi, and T. L. van Pool. 2010. Cultural traits as units of analysis. *Philosophical Transactions of the Royal Society B* 365: 3797-3806. [doi:10.1098/rstb.2010.0012]

Describes how cultural traits are units of replication, modifiable through recombination, loss or partial alteration within an individual's mind. Argues that cultural traits are transmitted during interactions, are populational and can be tracked at an individual level, and that traits can be manifest in the archaeological record.

Pagel, M. 2013. *Wired for culture: Origins of the human social mind*. W. W. Norton and Co.

A popular science book, ideal as an introductory overview of evolutionary perspectives on culture. Available*online[<http://books.wwnorton.com/books/detail.aspx?ID=24883>]*.

Rendell, L., R. Boyd, D. Cownden, M. Enquist, K. Eriksson, M. W. Feldman, L. Fogarty, S. Ghirlanda, T. Lillicrap, and K. N. Laland. 2010. Why copy others? Insights from the social learning tournament. *Science* 328: 208-213 [DOI: 10.1126/science.1184719]

Describes the cultural evolution equivalent of Axelrod and Hamilton's (see *Cooperation and Reciprocity*) cooperation tournament, to investigate strategies and benefits of copying the

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behavior of others. Strategies involving a large degree of social learning were particularly successful.

Whiten, A., R. A. Hinde, K. N. Laland, and C. B. Stringer. 2011. Culture evolves. *Philosophical Transactions of the Royal Society B* 366: 938-948. [doi:10.1098/rstb.2010.0372]

Provides an excellent overview of the most recent thinking and research, as well as introducing a full discussion meeting with 24 associated articles on cultural evolution by some of the field's leading researchers.

Language

No other species uses language in the same complex and reflexive manner as humans. Kirby 2007 is a brief review describing evolutionary explanations and processes involved in language evolution. Pinker 2007 provides a longer and more general synthesis of theories of language and is also an excellent starting place. Tomasello 2008 places language within the context of communication systems among the higher primates and arguing that it derives from the need for coordination of social cooperation. Dunbar 1993 also argues for a social origin, indeed arguing that language was necessary to maintain complex large groups. Along similar lines, Worden 1998 argues that language is fundamentally connected with social intelligence. Whatever its functional origins, Kirby et al. 2007 argues that cultural transmission is as important as individual learning and biological evolution. Senghas et al. 2004 provides a real-world case study of social transmission and the development of a new language, while Caldwell and Smith 2012 provides an example of an experimental approach.

Caldwell, C. A. and K. Smith. 2012. Cultural evolution and perpetuation of arbitrary communicative conventions in experimental microsocieties. *PLoS ONE* 7: e43807.

[DOI:10.1371/journal.pone.0043807]

Shows that arbitrary and contrasting conventions were rapidly established within microsocieties, which were transmitted to and readily adopted by naive newcomers.

Dunbar, R. I. M. 1993. Co-evolution of neocortex size, group size and language in humans.

Behavioral and Brain Sciences 16: 681 –735. [DOI: 10.1017/S0140525X00032325]

A functional argument for evolution of language. Argues that language replaced the mode of maintaining social cohesion in primates – grooming. The author's analysis suggests that development of language was enabled by significant increase in neocortex size, consistent with his social brain hypothesis (see *Social Cognition*).

Kirby, S. 2007. "The evolution of language". In *The Oxford handbook of evolutionary psychology*.

Edited by Dunbar, R. I. M., and L. Barrett, 669-681. Oxford University Press.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

A brief but very informative review of language evolution from the point of view of a leading evolutionary linguist and experimentalist.

Available*online[<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198568308.001.0001/oxfordhb-9780198568308>]*.

Kirby, S., M. Dowman, and T. L. Griffiths. 2007. Innateness and culture in the evolution of language.

Proceedings of the National Academy of Sciences USA 104: 5241–5245.

[DOI: <http://dx.doi.org/10.1073/pnas.0703232104>]

Present mathematical models comparing models of language evolution by individual learning and biological evolution with a third possibility, that of cultural transmission. They argue that cultural transmission can profoundly influence the evolutionary process, providing an alternative mechanism for evolution of language properties to the traditional nativist and adaptationist explanations.

Pinker, S. 2007. *The Language Instinct: How the mind creates language*. Allen Lane.

A classic book from one of the field's most prominent figures, originally published in 1994 but updated in 2007. In an accessible, wide-ranging synthesis, Pinker explores competing ideas about the evolution and development of the language faculty.

Available*online[<http://www.harpercollins.com/book/index.aspx?isbn=9780061336461>]*.

Senghas, A., S. Kita, and A. Özyürek. 2004. Children creating core properties of language: evidence from an emerging sign language in Nicaragua. *Science* 305: 1779-1782

[DOI: [10.1126/science.1100199](https://doi.org/10.1126/science.1100199)]

An interesting example of the birth of a real language, amongst deaf Nicaraguans, over 25 years. Authors argue that early segmentation and recombination in structured expressions reflect mechanisms with which children learn language, and demonstrates that children possess learning abilities that are capable of giving language its fundamental structure.

Tomasello, M. 2008. *Origins of human communication*. MIT Press.

A thoughtful account of human communication, arguing that the fundamental basis of human communication is cooperative social interaction. He argues that purely linguistic dimensions of human communication are cultural conventions and constructions created by and passed along within particular cultural groups. Available*online[<https://mitpress.mit.edu/books/origins-human-communication>]*.

Worden, R. (1998). "The evolution of language from social intelligence". In *Approaches to the evolution of language: Social and cognitive bases*. Edited by J. R. Hurford, M. Studdart-Kennedy, and C. Knight, 148-166. Cambridge University Press.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: [10.1093/obo/9780199941728-0025](https://doi.org/10.1093/obo/9780199941728-0025)

Describes how problems of sociality, and the capacity of theory of mind in particular, is integrally linked to language and effective communication. To make this point, he points out that the language processing parts of the brain are small compared to the frontal cortex which deals with social cognition.

EVOLUTIONARY MEDICINE

According to the terminology in Tinbergen's 1963 (see **Foundations in Evolutionary Theory**), conventional medicine is usually focused on proximate causes of illness and disease. In contrast, evolutionary medicine addresses ultimate causes, particularly incorporating functional interpretations. Williams and Nesse 1991 effectively launched the field with a seminal paper heralding "The Dawn of Darwinian Medicine". Stearns et al. 2010 provides a useful update. Ultimate causes of disease and functional interpretations are ways of thinking about problems with which evolutionary psychologists are well-acquainted. Furthermore it has been argued that several conditions are the product of a mismatch between physiological adaptations for ancestral environments and those experienced today, also very much the research terrain of evolutionary psychology. Eaton et al. 1997 is an example, where they deal with contemporary levels of obesity in evolutionary perspective. Accordingly, many evolutionary psychologists have interests in aspects of evolutionary medicine, particularly in psychopathy. More recently there has been growing interest in other behavioral insights into health and wellbeing, notably the idea of a behavioral immune system. These two areas of psychopathy and the behavioural immune system are therefore treated in more detail in the following sections.

Eaton S. B., S. B. Eaton, and M. J. Konner. 1997. Paleolithic nutrition revisited: a twelve-year retrospective on its nature and implications. *European Journal of Clinical Nutrition* 51: 207–16. [DOI 10.1038/sj.ejcn.1600389]

The authors analyze the nutritional properties of wild game and uncultivated vegetable foods, evaluate archeological remains, and describe the diet of recent hunter-gatherer societies, to estimate an 'average' Paleolithic diet which can be contrasted with dietary intakes of any modern population.

Stearns, S. C., R. M. Nesse, D. R. Govindaraju, and P. T. Ellison. 2010. Evolutionary perspectives on health and medicine. *Proceedings of the National Academy of Sciences* 107: 1691–1695. [DOI 10.1073/pnas.0914475107]

Provides a recent update on the promise and scope of current research in evolutionary approaches to health and medicine. It also introduces a Colloquium with 17 associated papers on specific aspects of this area, including public health, ageing, parent-offspring conflict, and a series of papers on genomic approaches to understanding disease and health.

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Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Williams, G. C., and R. M. Nesse. 1991. The dawn of Darwinian medicine. *Quarterly Review of Biology* 66: 1–22. [DOI:10.1086/417048]

A seminal paper effectively launching the new field, provides an excellent overview of its scope and potential.

Psychopathy

Nesse 2005a and Troisi 2012 provide excellent overviews of this issue. Nesse 2005b introduces the concept of the smoke detector principle (how the body may be designed by selection to react with low thresholds to potential threats (sometimes producing ‘false alarms’) in order to ensure that responses to serious threats are never missed) and how it can cause chronic suffering. Brüne 2004 reviews evolutionary insights into schizophrenia.

Brüne, M. 2004. Schizophrenia - an evolutionary enigma? *Neuroscience and Biobehavioral Reviews* 28: 41–53. [doi:10.1016/j.neubiorev.2003.10.002.]

Schizophrenic symptoms occur in every human culture and are associated with lower fecundity, suggesting that genetic susceptibility have unknown adaptive benefits. The article describes evolutionary hypotheses of schizophrenia, arguing that a symptom-based approach to psychotic disorders in evolutionary perspective may improve upon the existing models of schizophrenia.

Nesse, R. M. 2005a. “Evolutionary psychology and mental health”. In *The Handbook of Evolutionary Psychology*. Edited by D. M. Buss, 903-927. Wiley.

An excellent introduction to evolutionary psychology approaches to mental health by one of the founders of evolutionary medicine.

Available*online[<http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471264032.html>]*.

Nesse, R. M. 2005b. Natural selection and the regulation of defences: A signal detection analysis of the smoke detector principle. *Evolution and Human Behavior* 26: 88-105.

[doi:10.1016/j.evolhumbehav.2004.08.002]

Presents an evolutionary explanation for experience of pain, fever, and fear at levels higher than necessary to generate appropriate responses, leading to suffering, using ideas such as the consequences of responding to and ignoring false alarms.

Troisi, A. 2012. “Mental health and well-being: clinical applications of Darwinian psychiatry”. In *Applied Evolutionary Psychology*. Edited by S. C. Roberts, 276-289. Oxford University Press.

Vividly describes how clinicians see potential in evolutionary psychiatry but not yet any concrete applications that they can employ in their own practice. He then goes on to argue

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and describe how evolutionary approaches already have practical use in each of the stages of diagnosis, therapy and prevention.

Behavioural Responses Promoting Health and Well-being

Schaller 2011 provides an introductory review of the concept of a behavioral immune system, Curtis, in Curtis et al. 2011 and Curtis et al. 2004, argues that the lynchpin of behavioral immunity is the emotion of disgust, one of the six universal emotions, now thought to be the outcome of evolutionary pressure to reduce infection risk. Fessler et al. 2005 describes elevated disgust sensitivity during pregnancy as compensation for suppressed maternal immunity. This follows an analogous explanation for nausea and vomiting in pregnancy (NVP) described in Flaxman and Sherman 2008, which is related to avoidance of harmful foods. Pepper and Roberts 2006 provide cross-cultural support for Flaxman and Sherman's hypothesis.

Curtis, V., M. de Barra, and R. Aunger. 2011. Disgust as an adaptive system for disease avoidance. *Philosophical Transactions of the Royal Society B* 366: 389-401. [DOI: 10.1098/rstb.2010.0117]

Argues that disgust, hygiene behavior and culture form an interlinked adaptive system reducing the dangers of disease, which is a product of the selection pressure of pathogens in the environment. Also reviews learning mechanisms and social learning heuristics, and how these are extended symbolically to cultural rules and manners.

Curtis, V., R. Aunger, and T. Rabie. 2004. Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society B* 271: S131–S133. [DOI 10.1098/rsbl.2003.0144]

Describes survey results from more than 40,000 individuals assessing images of disease threat. Relative to controls, images showing disease threat were judged more disgusting; women reported higher disgust sensitivity and threat associated with strangers were judged especially disgusting, suggesting that disgust is an evolved response to disease risk cues.

Fessler, D.M.T., S. J. Eng, and C. D. Navarrete. 2005. Elevated disgust sensitivity in the first trimester of pregnancy: Evidence supporting the compensatory prophylaxis hypothesis. *Evolution and Human Behavior* 26: 344–351. [doi:10.1016/j.evolhumbehav.2004.12.001]

Pregnancy involves dramatic changes in immunocompetence, with the first trimester being a period during which the costs of exposure to pathogens are greatest. This paper tests differences in disgust sensitivity across trimesters, providing evidence that women compensate for suppressed immune function at this time by behaviorally reducing pathogen risk.

Flaxman, S. M. and P. W. Sherman. 2008. Morning sickness: adaptive cause or nonadaptive consequence of embryo viability? *American Naturalist* 172: 54-62. [DOI: 10.1086/588081]

Full citation:

Roberts SC. 2014. Evolutionary Psychology. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Discusses evidence for an adaptive function of nausea and vomiting in pregnancy (NVP, also known as "morning sickness"). Argues that NVP reduces intake of potentially harmful food items during the first trimester, a period of vulnerability to the foetus and also, through immunosuppression, in the mother.

Pepper, G. V. and S. C. Roberts. 2006. Rates of nausea and vomiting in pregnancy and dietary characteristics across populations. *Proceedings of the Royal Society B* 273: 2675-2679. [DOI 10.1098/rspb.2006.3633]

Provides a test of Flaxman and Sherman's Maternal and Embryo Protection hypothesis for NVP by comparing NVP prevalence rates in 56 studies and 21 countries with population-specific *per capita* dietary intake rates. Controlling for geographical region, NVP rates are associated with, for example, high intakes of meat and alcohol, which are potentially harmful to the foetus.

Schaller, M. 2011. The behavioural immune system and the psychology of human sociality. *Philosophical Transactions of the Royal Society B* 366: 3418-3426. [doi:10.1098/rstb.2011.0029]

Describes the suite of behaviors that help reduce infection risk, including aversions to diseased individuals or sources of infection such as wounds. Also outlines important implications for human social cognition and social behavior, including on social gregariousness, person perception, intergroup prejudice, mate preferences, sexual behavior and conformity.

APPLICATIONS

Evolutionary psychologists are increasingly interested in potential application and societal impact of their research. Crawford and Krebs 1997 includes a section on applications in its handbook of evolutionary psychology. Roberts 2012 provides a series of articles which together reviews approaches on a broad range of issues. Roberts et al. 2012 summarizes issues involved in applying evolutionary psychology and introduces a further set of articles. Miller 2010 and Saad 2011 provide popular accounts of applying evolutionary perspectives on consumerism.

Crawford, C. and D. L. Krebs, eds. 1997. *Handbook of evolutionary psychology: ideas, issues, and applications*. Lawrence Erlbaum.

The section on applications contains 11 articles, notably dealing with environmental issues, sexual aggression and family violence.

Miller, G. 2010. *Spent: sex, evolution and consumer behavior*. Viking Books.

A popular account of insights from evolutionary psychology on consumer culture and how people decide what to spend money on.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

Available*online[http://www.us.penguingroup.com/nf/Book/BookDisplay/0,,9780143117230,00.html?Spent_Geoffrey_Miller]*.

Roberts, S. C., ed. 2012. *Applied Evolutionary Psychology*. Oxford University Press.

The first book dedicated to applications, with 25 chapters focusing on issues in relation to business, family, society, health, marketing and technology.

Available*online[<http://ukcatalogue.oup.com/product/9780199586073.do#.UakyB9I3uoU>]*.

Roberts, S. C., M. van Vugt, and R. I. M. Dunbar. 2012. Evolutionary psychology in the modern world: applications, perspectives and strategies. *Evolutionary Psychology* 10: 762-769.

Provides an overview of prospects for applying evolutionary psychology, some issues that arise, and introduces a special issue with an associated set of 11 papers, each addressing specific applications.

Saad, G. 2011. *The Consuming Instinct*. Prometheus Books.

Another popular account of the evolutionary perspective on consumerism (see also Miller 2010).

Available*online[http://www.prometheusbooks.com/index.php?main_page=product_info&cPath=188&products_id=2021]*.

Full citation:

Roberts SC. 2014. *Evolutionary Psychology*. Oxford Bibliographies in Evolutionary Biology. Ed. J. Losos. New York: Oxford University Press. doi: 10.1093/obo/9780199941728-0025

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