

A syllabus for evolutionary medicine

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Evolutionary medicine (also known as Darwinian medicine) is the application of modern evolutionary theory to matters of human health and disease^{1,2}. A great strength of evolutionary medicine (EM) is its capacity to gather the diverse strands of medical science and practice and weave them into a coherent explanatory narrative. Hence it complements knowledge of 'proximate' causes derived from basic medical sciences³ and has the potential to become the key organizing principle for medical education^{1,4}.

The study of medicine often strikes students as an unsystematic conglomeration of information and skills—relevant to medicine, but gathered from a wide variety of domains and without any linking theoretical rationale. The curriculum coheres only in terms of its common focus upon the health of the human organism. This *ad hoc* convergence is reasonable from a purely pragmatic, vocational perspective; but the curriculum lacks the intellectual structure that ought to characterize a scholarly discipline.

I first became interested in an evolutionary framework for medical education while a lecturer in anatomy—a subject that is too often taught in a non-conceptual fashion, as merely a set of terms and relations. Evolutionary theory contributed a narrative, and comparative anatomy embedded the human being within the rest of biology. As each new anatomical system arose on the curriculum it was slotted into an historical evolutionary scheme. For instance, the respiratory system was introduced by discussing the problem of oxygen diffusion in animals as body size and physical activity increased, and the various adaptations to increase the surface area for gas exchange that arose through natural selection. Evolutionary considerations also illuminate suboptimal or idiosyncratic aspects of anatomy such as the positioning of the larynx anterior to the oesophagus (which renders human beings liable to choking), and the peculiar hairpin pathway of the recurrent laryngeal nerve.

EVOLUTIONARY PSYCHOLOGY—THE SCIENCE OF HUMAN NATURE

The relevance of modern evolutionary theory to human health goes beyond this kind of reconstructed anatomical or

physiological narrative. The new discipline of evolutionary psychology has extended the biological sciences into areas previously the domain of the social sciences⁵. Increasingly, evolutionary theory is providing knowledge about the instructive basis that underlies many human behaviours. For example, male/female health differentials can be analysed in terms of the minimum investment males and females bring to rearing offspring and their differential variance in reproductive potential. The divergence in optimal reproductive strategies underpins phenomena as various as sexual dimorphism, the role of testosterone, deaths from accidents and rates of homicide⁶.

Evolutionary psychology is not deterministic and recognizes that adaptive flexibility is a behavioural characteristic of human beings. However, the reason for such flexibility is that we have *more* instincts than other animals, not fewer instincts. Instincts are the specialized cognitive mechanisms that generate behaviour; and they are assumed to be fixed and finite in number, and universal throughout humankind. Distinctively human instincts arose in response to the selection pressures of a nomadic, foraging hominid society on the African savanna⁵, since when social conditions have changed too fast for evolution to track them. Ill-health can arise from the mismatch between palaeolithic instincts and modern conditions¹.

Dietary preferences provide a good example¹. Salt is necessary for life and was a scarce commodity under ancestral conditions, which is why an appetite for salty food evolved. Ripe fruit is sugary and nutritious while unripe fruit is toxic; thus, human beings evolved to taste sugar as sweet and gratifying, and unripe fruit as sour and aversive. Under modern conditions these instinctive appetites lead to the typical pattern of pleasurable food purchasing—crisps and other salty snacks, chocolate and other sugary sweets. Although such preferences do not rigidly dictate eating patterns, they are none the less a part of universal human nature. Modern human beings must *learn* how to balance their diets and control their calorie intake, because optimal consumption patterns do not happen instinctively.

CRITICISMS AND REFUTATIONS

The scope of evolutionary explanations has greatly expanded since the theory of natural selection was published in 1859, especially in its human applications⁵⁻⁷.

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The scientific status of the theory of natural selection has never been higher, and it is recognized as one of the greatest scientific insights of all time, with Charles Darwin a worthy peer of Newton and Einstein. Daniel Dennett has described evolutionary theory as being like a 'universal acid' which dissolves anything that tries to contain it⁸. This metaphor brilliantly captures its ambivalent power, which simultaneously operates as a fruitful biological concept and a subversive influence on human affairs⁹.

'Darwin's dangerous idea' it may be; but natural selection is real, whether we like it or not. Recent advances include: enhanced understanding of the evolutionary basis for the major steps in the history of life on earth; rigorous mathematical modelling of the phenomena of sexual selection and cooperation; discovery of the importance of coevolution as a driving force in evolutionary 'arms races', especially the role of parasites; the prediction and discovery of whole classes of 'ultra-selfish' genes which promote their own reproduction even at the expense of the organism they inhabit; the insight that human intelligence is primarily designed for enhanced social interaction, rather than to promote ecological survival; and an appreciation of the evolved basis of the 'language instinct'^{3,5-8}. And that list is far from exhaustive.

It is sometimes suggested that historically reconstructed evolutionary narratives are merely 'just-so stories' which concoct *post hoc* pseudo-explanations based on circular reasoning and devoid of substantive content. Certainly, the worst examples of evolutionary speculation deserve such ridicule. But a well constructed evolutionary narrative, even when it goes beyond current knowledge, will always point beyond the evidence used in its construction, and will therefore make testable predictions.

The question of *whether* natural selection is relevant to human affairs has already been answered: evolutionary theory *is* relevant—and profoundly so. The task is to discover exactly how.

LIMITATIONS OF EVOLUTIONARY MEDICINE

None the less, it would be wrong to imply that EM consists of an off-the-peg set of techniques ready and waiting to be applied to clinical research and practice. Rather, EM is an approach to understanding health and disease which may (or may not) be valuable in any given instance.

For example, when we apply evolutionary theory to psychiatry¹⁰, anxiety forms a justifiable category. Anxiety can be seen as an extreme form of an adaptive emotion, the nature and foundations of which are supported by a wide range of convergent scientific evidence¹. However, many current psychiatric diagnoses are of dubious nosological validity¹¹, which means that any efforts to 'explain' them in evolutionary terms are likely to prove misleading. For

example, psychodynamic theory has no validity in the light of modern scientific psychology and neuroscience, so attempts to synthesize Freudian theories with natural selection^{12,13} are illegitimate and doomed to fail. When a diagnostic schema or causal model does not constitute a genuine, homogenous and discrete biological category (and this probably applies even to depression and schizophrenia¹¹), then EM is unlikely to be helpful.

Applying evolutionary theory to medicine is neither straightforward nor easy. Evolutionary theory focuses on genes, while doctors focus on the human organism. And health is only an indirect consequence of natural selection; it is a side-effect of the need for organisms to survive long enough, and compete well enough, to attain the highest possible reproductive success relative to their rivals³. The perspective of EM is one of maximizing the health and longevity of a human organism under rapidly changing modern conditions¹⁴. Hence standard evolutionary theory cannot be translated straightforwardly into clinical practice, and EM requires further work to develop and clarify its distinctive viewpoint.

Box 1: Syllabus for evolutionary medicine

1. Introduction to natural selection—the gene-centred view
2. The nature of health—causes of human longevity
3. Evolutionary psychology, the modular mind and 'human nature'
4. The ancestral environment of evolutionary adaptedness, and the evolution of cooperation
5. Genetic disease and evolution—heterozygote advantage, examples of recent human evolution
6. Coevolution—predators, prey; hosts and parasites; humans *versus* humans
7. Diet and health—comparing ancestral and modern nutrition
8. Pathogens and parasites—the evolution of virulence; the evolution of sexual reproduction
9. Sexual selection and health: the evolutionary roots of sexual differences in health
10. Health in men
11. Health in women
12. Ageing and evolution—theories of senescence, cancer, degenerative diseases
13. Modern maladaptation—drugs and other addictive agents; socioeconomic health inequalities
14. Psychiatric illness and evolution
15. Social aspects of health and evolution—population growth

Indeed, the special value of an evolutionary theme to medical education lies in the fact that it is a living, developing science. Too much of medical education is stale, settled or simple—its challenges largely mnemonic, pragmatic and procedural. Evolutionary theory is, by contrast, conceptually complex, intellectually demanding and scientifically dynamic. EM might assuage the thirst for rigorous speculation and debate which bright students often possess, yet which the conventional medical curriculum leaves unsatisfied.

A SYLLABUS FOR EVOLUTIONARY MEDICINE

Given its power as an organizing principle and its potential as an intellectual stimulant, EM could profitably be a continuous theme running throughout the medical curriculum. Initially, it could be offered as an optional series of teaching and discussion sessions. In the longer term this might be made compulsory, and eventually extended throughout the whole curriculum.

For the past two years I have been teaching a course on the evolutionary psychology of health to final year BSc students. This experience has formed the basis for a new module for the intercalating Bachelor of Medical Science class. A brief summary of the syllabus of this module may help to clarify the scope of the subject, and serve as an example for discussion.

The course has three aims. Students should understand:

- Modern evolutionary theory, the evolutionary origins of human beings and the evolutionary pressures acting upon them under ancestral conditions
- The evolutionary foundations of health in the human organism
- Several worked-through examples of the complex relationship between natural selection and important dimensions of health in contemporary society.

The course comprises 15 two-hour sessions, supported by private study. Box 1 summarizes the syllabus.

The time seems ripe for making the first moves toward establishing evolutionary medicine as an academic discourse. It would be valuable to bring together a network of enthusiasts to form a society for EM. Such a society could work as a think-tank to explore and promote the subject's potential in research, teaching and clinical explanation.

Interested parties are invited to write to me at the address on this paper or by e-mail to <bruce.g.charlton@newcastle.ac.uk>

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