

Book Review

On the Aims of Evolutionary Theory

A Review of Odling-Smee, J. J., Laland, K. N. and Feldman, M. W. (2003) *Niche Construction: The Neglected Process in Evolution*. New Jersey: Princeton University Press.

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One often heard complaint against evolutionary approaches to the behavioural sciences is that humans have in some way acted to escape their own evolutionary history. Critics who might take this approach cite the rise of complex culture and the huge impact we have had in terms of transforming our own environment. Surely, we have left our ancestral troubles behind and therefore evolutionary theory has nothing to say to us when we come to interrogate the current state of human nature. This argument, however, clearly assumes that changed environments impose no selection pressures of their own. This assumption is clearly false as work on “niche construction” demonstrates.

Odling-Smee, Laland and Feldman (OLF) define niche construction as follows:

Niche construction occurs when an organism modifies the feature-factor relationship between itself and its environment, either by physically perturbing factors at its current location in space and time, or by relocating to a different space-time address, thereby exposing itself to different factors. (2003: 41)

Elsewhere the same authors have defined this phenomenon in slightly different terms:

Niche construction occurs when an organism modifies the functional relationship between itself and its environment by actively changing one or more of the factors in its environment, either by physically perturbing these factors at its current address, or by relocating to a different address, thereby exposing itself to different factors. (Laland, Odling-Smee and Feldman, 2000: 165)

These definitions can perhaps be further distilled. The take-home message that OLF

wish to convey is that organisms do things that have feedback consequences and these consequences in turn alter the designs of the organisms themselves, or of others. The book presents a wealth of rich and detailed ecological data to support this message and it makes for fascinating reading. For this reason alone the book is worth reading. For the sake of brevity I shall mention only one example in the hope that this will further clarify the message:

The action of earthworms during burrowing causes major changes in the physical and chemical structure of the affected soil. This has numerous effects including facilitating greater plant growth, which in turn benefits the earthworms in terms of increased plant debris to consume. Such effects may take many generations to become established. It is also probable that earthworm epidermal structures and the amount of mucus secreted has changed over time as these other effects took hold – for burrowing through the soil has become a different task thanks to long-term worm behaviour. So here we see the actions of earthworms creating an environmental niche – namely a specific soil type – and this in turn feeds back to affect the worms such that their environment is improved and their phenotype modified in light of these changes.

It is worth noting that niche construction can affect future generations, as in the earthworm case, or the current generation, as well as individuals or groups. What is more, it can affect other species too, as has happened for a variety of plants in the earthworm example, and it can also have knock-on effects for other neighbouring ecosystems. In short, organismic action can have effects at multiple levels and at multiple loci.

Given the wealth of data presented in the book, and elsewhere, one might be forgiven a feeling of surprise at the subtitle of the book. How can niche construction be considered neglected if OLF can draw on so much science to illustrate the phenomenon? But the use of the term ‘neglect’ is in fact less surprising than the use of the term ‘process.’ The simple definition of a process is “a series of actions that produce a change or development” (Collins English Dictionary, 1991), and as such the gloss of ‘niche construction’ does seem to encapsulate a series of actions that cause change. However, if we consider another use of ‘process’, that relating say to computation, we endow the term with a sense of consistency. This consistency is the sort found in the formal operations of algorithms that mindlessly manipulate pertinent input. Niche construction, as described by OLF does not have this characteristic at all, but instead amounts simply to a long list of situations in which very different actions lead to very different changes. This in itself would not be a problem if they did not claim at the end of the book that “we shall have to recognize that evolution depends not on one, but on two general selective processes: natural selection and niche construction”¹ (p. 385), for natural selection *is* an algorithmic process² and therefore the comparison of natural selection with niche construction is not commensurate when viewed in this way.

It is certain that OLF would object to the above point about the use of the term ‘process.’ They might argue that the regularity of niche construction is not to be

found in the organisms and niches that are affected but in the very fact that there are organisms and niches and that organismic action can lead to change in niches that in turn impacts on their phenotype and, ultimately as a consequence, their genotype. Surely this is the description of an algorithmic process? Well, only if one assumes something consistent about the feedback between niche and organism. If we think about the complexity that the book is trying to capture from the perspective of information theory this point becomes clearer:

Evolutionary theory is a theory of design. More specifically it accounts for the origins and persistence of apparent design in organisms by regarding them as a consequence of natural selection³. Natural selection is in fact not a superordinate process operating over genotypes, but an economic consequence of the way in which genotypes and phenotypes operate. None the less it is often useful to regard natural selection as an algorithm sifting through possible phenotype space and selecting specific traits and consequentially their associated genes. It is important to be clear that this is an instrumental stance that helps to get science moving along⁴. It is also important to be clear that natural selection causes real sequential change.

Natural selection produces designed systems, where a system is “a group or combination of interrelated, independent, or interacting elements forming a collective entity” (Collins English Dictionary, 1991). Through different configurations of the component elements a system can exist in a number of different states, and can be said to suffer a degree of uncertainty. Input that can change the state of a system from, say, S_1 to S_2 is defined as information. By changing the system to a specific state the input, or information, reduces the uncertainty of the system. If the systems can exist in a large number of states, from S_1 to S_n , then the uncertainty is great and the input that determines a state is highly informative. In this way information is understood in terms of a specific arrangement relative to all probable arrangements, in other words, information is understood probabilistically. This is the classic definition of information from Shannon (1948).

Input will only work as information if there is a system that can accept that input and have its uncertainty reduced. This means that systems are ‘prepared’ for certain inputs and can treat them as information. There is nothing *contentful* about the input, no essence, if you will, that can alter the system through its own means. The input acts as a key to a specific lock, and that is all. Systemic preparedness is a design feature that allows the system to utilize a defined array of inputs in order to change its state, and as a design feature of organisms it requires a theory of design. If we take information theory not as a theory but almost as an axiomatic statement of how the world in fact is⁵, this means that the requirement to have a theory of design is very strong indeed and that it must have the key feature of explaining how inputs get to be used as information. Neo-Darwinism fits this explanatory niche⁶.

Natural selection builds organisms that can accept inputs from specific niches and that can use this information. The sources of input within the environment can change, but this will not immediately force a reorganisation of organisms in order to then use new inputs as information. Instead, a change must happen within the

organism design that happens to coincide with the new inputs. Neo-Darwinism explains such changes; they are the result of fortuitous mutations. For OLF to claim niche construction as a second evolutionary process they must propose a cause for design change within organisms that permits new environmental inputs to be informative, for changes in the environment alone are not sufficient. It is at this juncture that the authors rely upon natural selection, and apply it as neo-Darwinism demands⁷. In short, what this book really tells us is that natural selection can happen once when a species is shaped to fit an environmental niche, and again when that species (or some other) so changes that environment that new adaptive problems emerge, and so on. To the best of my knowledge no one has considered neo-Darwinian evolution to be a one-shot game, yet the book reads as if this was the predominant view and that the authors have stumbled onto something new. Perhaps the blurb on the back cover says it best – the “seemingly innocent observation that the activities of organisms bring about changes in environments is so obvious that it seems an unlikely focus for a new line of thinking about evolution.”

The informational perspective on evolutionary theory not only clarifies the process that niche construction relies upon, but it also illuminates discussion about the relationship between evolution and culture, which is something the authors feel could be enhanced by their thesis.

Ideational cultures are not the product of genes but rather the product of evolutionarily designed minds operating in a social context. The outputs of these designed minds are constrained, and they are only outputted as the consequence of appropriate inputs. That there is variation in ideational content across individuals, across generations and across cultures indicates that there is learning and an opportunity for more than one solution to certain problems. But learning is not to be seen as an entirely free situation: learning mechanisms will be designed to deal with certain domains of problem. Even if learning were to rely on some order of associative algorithm it would not simply associate everything with everything, for then nothing would be learnt. Instead it is important that associations be constrained to appropriate classes of thing and this appropriateness would be a consequence of the adaptive problems faced by past generations.

Perhaps the best way to conceive of evolved cognition, of any sort, is as a calibrating device. Natural selection has endowed organisms with many fixed phenotypic features that meet adaptive demands. However, immediate environments change and new problems present themselves. Cognitive devices that can produce an array of behavioural outputs in the appropriate situations can help to guide organisms through such change. It is important to realise however that the designed nature of such cognition is a consequence of evolution through natural selection and these cognitive systems will only be prepared for a limited range of inputs. So, there is some tolerance (or slack) in the organismic system and cognition calibrates the organism, using this tolerance, to meet environmental demands on a moment-to-moment, day-to-day or year-on-year basis, depending upon the nature of the problem.

As a social species, humans have cognitive systems that allow the passing on

of solutions to problems; we can learn to perform a solution that someone else has formulated. Social learning is an efficient calibrational tool, since it reduces trial-and-error time factors. This works because we share the same design features that allow us all to accept the same inputs and use them informationally. Seen like this, we have no need to discuss the concept of memes as units of cultural inheritance, for ideational culture is in no need of an additional explanation of its causes since the intrinsic⁸ elements of cultural theory are provided by an understanding of evolved cognition. Things only become information when they meet the appropriately designed system. Yet, OLF claim that,

Cultural niche construction can, of course, cause rates of environmental change that really are too fast for human genetic evolution to track... In the past 25 to 40 thousand years the dominant mode of human evolution has probably been purely cultural. However, that does not mean there has been no evolutionary feedback from niche construction: it merely switches the evolutionary response to the cultural domain. Under such circumstances, cultural niche construction should have favoured further cultural transmission, or coevolution between subsets of culturally transmitted information, sometime called memes. (p. 249)

Here we see a clear claim not only for memes as intrinsic units of cultural inheritance that are unconnected to cognitive kinds, but we also see niche construction being spoken of as a regulating process in its own right. It is undoubtedly the case that many cultural activities construct new niches for our species, and it is highly likely that many of them alter the selection pressures we confront. OLF give examples of this, such as the emergence of lactose tolerance as a consequence of dairy farming. But, as argued above, the full explanation for lactose tolerance relies, in the end, on natural selection. The only way one could conceive of niche construction as a process akin to natural selection is to assume that there is something in the content of inputs that can rewire a designed system and cause it to perform useful behaviours. This violates all of the principles of information theory, and makes it very likely that OLF have simply neglected the process of natural selection during their thinking.

Notes

1. It is interesting that sexual selection does not feature in this robust claim.
2. Though see the argument below for a qualification on this point.
3. I will not discuss sexual selection here, for the sake of brevity, but I hope that it is clear that sexual selection is (a) a consequence of the evolution of sex and (b) fits with the general scheme outlined in this review.
4. It is also worth noting that this same argument can be applied to the notion of algorithms used in computational theory.
5. And most natural scientists are dealing with systems and change within those

- systems so, to some interesting extent, this must be a tacit consensus opinion.
6. Some critics of evolutionary approaches argue either that evolutionary theory is an unfalsifiable approach and therefore unscientific, or conversely that it is merely a theory with the fallibility of all theories and should not be given such a central place in modern thinking. This odd situation is a consequence of misunderstanding that conflates the requirement for a theory of design in the natural sciences with the current front runner theory, neo-Darwinism. Neo-Darwinism is in fact falsifiable, for there are many empirically testable claims made, for example within modern genetics which currently explains the core principle of inheritance. However, if it were to be falsified a new theory would have to replace it, in order to explain design in a non-theological fashion, and this would have very many features in common with neo-Darwinism simply because of the explanatory burden such a theory would have to carry. The notion that design must be explained non-theologically is, of course, not a scientific theory but rather a principled request for a scientific theory that emerges both from taking information theory as foundational and from larger commitments to materialism and its relata.
 7. And note, following from footnote 6, that if OLF were to propose a new process to account for this design it would look very much like natural selection, because of the explanatory burden imposed by informational and non-theological commitments, and they would have to explain the possibility of two very similar processes operating in nature. Or rather, how two stable economic arrangements that both account for design and sequential change can emerge and coexist.
 8. Genes provide the intrinsic element of evolutionary biology, but cultural evolution does not require an intrinsic element, which is the role requested of memes, because culture is the product of evolved minds.

References

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