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COMMENTARY

On hermit crabs and humans

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This is a commentary on Flynn *et al*. (2012).

Flynn, Laland, Kendal and Kendal's article (this issue) plays a valuable role in two ways. First, it demonstrates how developmental psychology can learn lessons from the latest research on developmental niche construction within evolutionary biology. Secondly, for those psychologists whose main focus is the cognitive mechanisms by which humans develop their particular suite of abilities, it is a useful reminder of the vast contribution of culture to shaping the modern human mind. Indeed, it is interesting to speculate on how much of the explanation of the abilities of modern humans should be properly apportioned to mechanisms of cognitive development compared to the extended accumulation of years of accumulation of cultural knowledge, practices, and artefacts that provide the social and educational niches within which humans are raised.

In this commentary, however, I want to focus on the evolution. How much of the evolutionary dimension of niche construction theory (NCT) should we import into developmental psychology?

Evolutionary psychology already exists as a sub-field of psychology. Developmental psychologists have sometimes viewed this sub-field with suspicion, particularly with respect to high-level cognition – not because there is any doubt that evolution has shaped us, but because evolutionary theories of high-level behaviour can sometimes appear as 'just-so' or post-hoc explanations, based on tenuous inferences about the selective pressures operating during the emergence of Homo sapiens. Moreover, evolutionary theories of high-level cognition are rarely constrained by neurobiological theories about the bespoke processing mechanisms that genes could feasibly deliver during brain development.

Nevertheless, Flynn *et al.*'s article is timely. Recent work within the *evo-devo* framework (e.g. Finlay, 2007) has begun to address the interface between evolution and brain development. And the relative importance of – and correlation between – genes and environments is increasingly recognised within behavioural genetics (e.g. Plomin, DeFries, McClearn & McGuffin, 2008). Gene–environment correlations are typically separated into three types: *passive* correlations (environments that are inherited along with genes; e.g. children who inherit genes for attention deficit hyperactivity disorder are more likely to be raised in an environment shaped by impulsive parents); evocative correlations (environments that are evoked by the inherited traits of the individual; e.g. pretty children may evoke different responses from carers than less pretty children), or *active* correlations (by virtue of their inherited traits, an individual seeks out or creates certain environments; e.g. an introvert might apply for a job working in a library). Niche construction falls most comfortably under the umbrella of active gene–environment correlation.

With respect to niche construction, the key question is, if humans are held to be the ultimate niche constructors (Smith, 2007), to what extent is the explanation for this an evolutionary one? Consider two different positions.

On the one hand, perhaps humans are similar to *hermit crabs*. Hermit crabs depend on gastropod shells for protection. They construct a much safer niche than their own body provides. Living in shells has constrained the evolution of hermit crab bodies by requiring a soft asymmetrical abdomen that can be coiled into a gastropod shell. Here, evolution of the organism has occurred in the context of its niche construction abilities. If humans are similar, there will be particular aspects of our niche constructing abilities that are directly explainable in evolutionary terms. We just need to find the mental faculties that correspond to the hermit crab's soft, asymmetrical abdomen. But note, for this adaptive process to take place across evolution, the niche construction has to correlate with the genome. That is, a niche constructing proto-ability, which confers some

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selective advantage, must be correlated with certain genes, so that those genes may be preferentially passed on to the next generation. In addition, the adaptation will place a constraint on the niche that can be constructed. The hermit crab cannot grow larger than the largest gastropod shells available, and its constructed niche cannot be much different from a shell; perhaps a hollow piece of wood or stone.

On the other hand, perhaps the relationship between human evolution and human niche construction is more like that between the *medium* and the *message*. If culture is the main vehicle of niche construction, evolution may have merely furnished a set of abilities that provides the medium through which the message of culture can propagate. The set of abilities might be something like, say, pro-social behaviour, parenting, language, plenty of spare association cortex, and extended plasticity. In this case, evolution would have little influence on the message that is transmitted through the medium, other than some weak constraints on what is perceivable, manipulable, and learnable. If culture is only weakly constrained by evolution, and culture is the origin of many of our particular mental abilities, then evolution wouldn't explain much about the details of the modern human mind.

There are, of course, many positions that lie intermediate between these two extremes. Perhaps some aspects of human niche construction are more like the hermit crab, whereas others are more properly thought of as having their origins in culture. Human social skills, relationships, and dominance hierarchies, for example, seem not markedly different from those of other primates, and where the social environment is the constructed niche, perhaps this is more like the hermit crab. But in other cases, it is clear that new brain systems have been sculpted by culture and its artefacts, such as the brain systems responsible for numeracy, literacy, and certain modes of reasoning (albeit, these are new brain systems constructed out of old parts under a scheme of *neuronal recycling*; see Dehaene & Cohen, 2007).

Either way, a central question is the extent to which cultural variation is constrained by the adaptations that rendered humans the ultimate niche constructors. A similar theme has long been pursued within the study of language acquisition, where researchers have asked how variable languages can be given the innate component that confers on humans (but not other primates) with a faculty complex language. Two points are worth noting. First, human culture has changed significantly faster than human genetics. Literacy and numeracy have emerged only in the past few thousand years; genetic innovations over the same period are mostly adaptations related to disease and diet. Second, human cultures provide for a variety of niches. This is because, for much of their history, human cultures required multiple specialized roles, such as farmers, tradesmen, soldiers, politicians, and so forth. It is hard to see how adoption of different roles within a culture could all simultaneously correlate with genotypic variations. This would undermine the conditions by which evolution can select for genes associated with particular acts of niche construction (in the way that the hermit crab's body fits a shell)

Flynn *et al*. are right to suggest that atypical conditions can provide clues to the centrality of niche construction in human development, and the genetic constraints that influence it. A similar path has been followed in the study of language development, where genetics disorders such as Specific Language Impairment and Williams syndrome have been used to explore genetic contributions to language acquisition, while various conditions of environmental deprivation, such as children who are born deaf, have been used to assess the impact of heritable environments. In the same way, atypical development might shed light on the wider questions of niche construction. For example, autism has been argued to represent a case of a failure to attend to social information early in infancy (see, e.g. Elsabbagh, Holmboe, Gliga, Mercure, Hudry, Charman, Baron-Cohen, Bolton, Johnson & the BASIS Team, 2011, for discussion). Such a failure might have cascading effects across development as the child fails to construct their social niche. If autism is primarily genetic in origin, this could tell us about the way evolution has encoded the typical developmental pathway of social niche construction.

Some heritable developmental disorders may point to a lack of adaptation. That is, there may have been pre-existing gradients of genetic variation that were of no relevance until the culture required individuals to learn certain skills. Dyslexia and dyscalculia are two such examples. In dyslexia, family lineages with slightly poorer representations of speech sounds were little worse off until a certain generation was required by its culture to learn the association between speech sounds and written scripts. In dyscalculia, family lineages with poorer representations of number quantities were little worse off until a certain generation had to engage these representations in a wider system for counting and arithmetic.

The most valuable contributions of a synergy between NCT and developmental psychology are first to highlight the importance of dynamic relationships between the individual and his or her physical and social environments; and second, to offer analytical methods to formulate and test hypotheses about these relationships.

This is consonant with new approaches to developmental theory that utilize the modelling tools of dynamical systems and distributed computation (Spencer, Thomas & McClelland, 2009). However, the evolutionary implications of NCT for the origins of the (modern) human mind are, as yet, less clear-cut.

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