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Research

Exploring the folkbiological conception of human nature

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Integrating the study of human diversity into the human evolutionary sciences requires substantial revision of traditional conceptions of a shared human nature. This process may be made more difficult by entrenched, ‘folkbiological’ modes of thought. Earlier work by the authors suggests that biologically naive subjects hold an implicit theory according to which some traits are expressions of an animal’s inner nature while others are imposed by its environment. In this paper, we report further studies that extend and refine our account of this aspect of folkbiology. We examine biologically naive subjects’ judgments about whether traits of an animal are ‘innate’, ‘in its DNA’ or ‘part of its nature’. Subjects do not understand these three descriptions to be equivalent. Both innate and in its DNA have the connotation that the trait is species-typical. This poses an obstacle to the assimilation of the biology of polymorphic and plastic traits by biologically naive audiences. Researchers themselves may not be immune to the continuing pull of folkbiological modes of thought.

Keywords: innateness; human nature; folkbiology; evolutionary psychology; public understanding of science

1. INTRODUCTION: HUMAN DIVERSITY AND THE CONCEPT OF HUMAN NATURE

In everyday speech, the phrase ‘human nature’ denotes something that all human beings share. The search for human nature has traditionally been the search for human universals. But this is only the simplest sense in which a species can have a shared, biological nature. An important theme in recent evolutionary biology has been phenotypic plasticity, both intra-generational and intergenerational (‘parental effects’), and both as an adaptive phenomenon and as a potential source of evolutionary novelty [1–7]. In this spirit, human nature can be conceived as including patterns of human difference as well as similarity (but see [8]).

One implication of adaptive phenotypic plasticity is that evolution produces developmental systems that incorporate many aspects of what would traditionally be regarded as the ‘environment’ [9–11]. Organisms influence their offspring not only via genetic heredity, but also via a number of other causal pathways. In a species like ours, the developmental system includes socialization and exposure to all the factors that make up a human culture. The ancient and highly

intuitive idea that the true nature of human beings is to be discovered by factoring out the interfering effects of culture is misguided. Human cultural variation does not mask some aboriginal human nature any more than variation between ant castes masks the true, universal nature of that species of ant.

Within the human evolutionary sciences, there is a growing appreciation for the role of developmental context, or ‘ontogenetic niche’ [12], in structuring cognition and behaviour. For example, recent work on the incest taboo suggests that this disposition is developmentally sensitive to childhood encounters such as co-residence with peers and the experience of one’s mother caring for a newborn [13]. Other psychological traits that have been classified as innate, including theory of mind and spatial representation, also exhibit cultural variability that can be traced to environmental influences on development (reviewed in [14]). A traditional way to reconcile environmentally induced phenotypic variation with the idea of a shared human nature is the idea of ‘disjunctive genetic programmes’ (e.g. [15]). This perspective regards human nature as a universally shared set of instructions that guide development down one of several pre-established pathways. But there is more to phenotypic plasticity than this. The role of developmental context need not be restricted to activating alternative outcomes, each of which played a historical role in the evolution of the

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One contribution of 14 to a Theme Issue ‘Evolution and human behavioural diversity’.

mechanism of plasticity [16]. Developmental systems are often able to produce viable phenotypes outside the specific parameter ranges in which they historically operated. As a result, phenotypic plasticity can generate novel, functional phenotypes, as has been dramatically demonstrated in Alexander Badyaev's work on the recent evolution of the North American house finch *Carpodacus mexicanus* [17,18].

We suspect that most evolutionary behavioural scientists, including evolutionary psychologists, human behavioural ecologists and dual-inheritance theorists, can accommodate a non-universalist, developmentally plastic view of human nature. Human behavioural ecologists have paid much attention to human diversity, attempting to explain behavioural variation as an adaptive response to social and ecological environments (see [19] for a review). Human diversity has also been an explicit focus of interest for dual-inheritance theorists who view culture as an important system of information inheritance in humans (e.g. [20,21]). While Tooby & Cosmides [15] hypothesized that the mind was 'monomorphic', and evolutionary psychologists have sometimes emphasized human universals, many evolutionary psychologists accept that human behavioural and psychological diversity can often be explained in evolutionary terms (e.g. [22–24]). Thus, evolutionary behavioural scientists' views about phenotypic plasticity and psychological or behavioural diversity are often no less sophisticated than those of evolutionary biologists working on animal behaviour or on non-behavioural traits.

However, despite this sophistication, evolutionary behavioural scientists occasionally endorse arguments or research strategies that seem to assume a very different conception of human nature—viz. that explaining variation is the job of historians, sociologists or cultural anthropologists, while explaining universals is the job of evolutionary scientists. We now give three examples of arguments, assertions or research strategies that seem to assume such a view. We do not mean to suggest that the researchers singled out here are unsophisticated or more likely to entertain erroneous views than others. Examples could have been found by looking at the writings of many other evolutionary behavioural scientists, and it would not surprise us to find examples in our own writings. The authors we have picked on not only *should* know better, they *do* know better. The interesting question is why this pattern of thought persists.

Consider first the following quotation from primatologist Sarah Brosnan:

There has been quite a bit of debate over whether prosocial behaviours in general are the result of natural selection or culture [25]. In other words, do people respond to inequity because they are somehow wired to do so or because they are trained by our complex cultural institutions to make such responses [26,27]? The presence of the roots of fairness in such a wide variety of taxa implies that at least some aspect of the response is evolved. ([28], p. 181)

Here, Brosnan associates being an adaptation (first sentence), developing independently of the environment ('being wired' in the second sentence), and

being species-typical (she refers to people in general). Furthermore, failing to be the product of evolution, being learned (which is contrasted to being wired), and being variable are all associated.

Turn now to moral psychologists Jonathan Haidt and Craig Joseph:

The nativist approach, on the other hand, holds that knowledge about such issues as fairness, harm, and respect for authority has been built into the human mind by evolution. All children who are raised in a reasonable environment will come to develop these ideas, even if they are not taught by adults. To the extent that there are differences across cultures, they arise because of local variation in the implementation of universal moral knowledge. ([29], pp. 55–56).

While Haidt and Joseph are normally sensitive to, and indeed have a theory about, moral cultural diversity, here they associate being the product of evolution with being species-typical (the human mind), and with developing without environmental input (second sentence). Note that they explicitly use the idea of innateness (nativism) to label this package of associations.

Finally, consider Murray Millar's recent article on implicit biases in *Evolution and Human Behaviour*, the leading journal in the evolutionary behavioural sciences:

Given the findings from the current study, it seems possible that some of these crib sheets may consist of implicit associations, i.e. we may have inborn implicit association networks that are responsive to contextual input. Implicit associations produced by natural selection may have different properties from explicit associations that are produced by associative learning. For example, innate associations may prove more resistant to change through processes akin to classical conditioning. ([30], p. 360)

Millar here associates species-typicality ('we' is meant to refer to all humans) being uninfluenced by the environment, and being an adaptation. The phrases 'produced by natural selection' and 'innate' are used in the last two sentences, respectively, as if they were more or less equivalent.

So, why do sophisticated evolutionary behavioural scientists overlook their own explicit theoretical commitments about the explicability of diversity in biological terms? We hypothesize that this oversight reflects the continuing influence of aspects of 'folkbiology' (§2). We propose that people tend to view evolved traits as species-typical because they conceive (either implicitly or explicitly) of evolved traits as innate and because they take innate traits to have three properties: innate traits have a function; they are species-typical; and their development does not depend on the environment. Conversely, if a trait is not species-typical, then, according to folkbiology, it is less likely to be innate and therefore a less likely candidate for evolutionary explanation. Thus, the folk concept of innateness stands in the way of a genuine evolutionary understanding of human behavioural and psychological diversity. Our hypothesis, then, is that, despite evolutionary behavioural scientists' theoretical sophistication on these matters, the folkbiological concept of innateness still sometimes influences the way that they

think about human diversity. Moreover, even when the actual science shows no such influences, it may be viewed through the prism of the folkbiological concept when it is reported to audiences outside the field.

To support this hypothesis, one would ideally provide comparative evidence that scientists' and lay people's understanding of diversity is, respectively, influenced by their folk concept of innateness. Demonstrating such a pattern requires a solid grasp of what the folk concept of innateness amounts to in the first place. Speculations about the way ordinary people think about innateness need to be replaced by systematic study. We have started to do precisely this in previous work, and in this article we expand our examination of the folkbiological concept of innateness in new directions.

2. FOLK BIOLOGY AND THE VERNACULAR CONCEPT OF INNATENESS

The view that the concept of innateness is a pre-scientific inheritance that has no positive scientific value was historically important in ethology and comparative psychology [31–34]. At the heart of this critique was the claim that the idea of innateness conflates different biological questions and leads researchers to commit fallacies of ambiguity. A fallacious inference of particular interest in the current context would be inferring from evidence that a trait is an adaptation to the conclusion that it is species-typical. When such inferences are laid out explicitly, it is clear that they do not follow without further evidence. However, critics have argued that if the discussion is conducted in terms of whether the trait is innate, a term that is used on different occasions to refer to each of these distinct, biological properties, it is easy to slide from one to the other.

The concept of innateness is the focus of an extensive literature in philosophy (reviewed in [35]). This was initially inspired by philosophical interest in Chomskyan linguistics, and more recently by interest in cognitive developmental psychology and evolutionary psychology [36]. The most substantive study of how innateness is used as a scientific construct is due to Mameli & Bateson [37]. They list no less than 26 proposed definitions of innate from the scientific literature and judge eight of these to be both genuinely independent definitions and potentially valuable scientific constructs. They suggest that an urgent research question is whether these different constructs are so tightly associated that little harm will come from conflating them, or whether they need to be kept distinct, in which case not calling them all 'innateness' would be an obvious first step.

Our own work to date has focused on how innateness is conceived by biologically naive subjects. We believe that a clear understanding of this subject is vital for two reasons. First, it is likely that the vernacular conception of innateness is the common ground from which the many different scientific conceptions are derived. So we hypothesize that it will mediate communication between scientific disciplines that have come to understand innateness in their own, distinctive manner. Second, the vernacular conception of innateness is the one relevant to

the public understanding of science. When findings about innateness are widely disseminated, they will primarily be interpreted using the vernacular conception of innateness.

We refer to the subject of our research as the folkbiology of behavioural development. 'Folk theories' are the views that non-scientists hold, either explicitly or implicitly, on topics that are also topics of scientific inquiry. Perhaps, the best-known example is the folk theory of dynamics in which bodies subject to a force receive a quantity of 'impetus' and continue in motion until this is exhausted [38]. One of the most rigorously investigated areas of folk theory is folkbiology [39–41]. People everywhere identify at least three general levels of biological classification: a 'generic species' category (e.g. wombats and bluegums), a super-ordinate category of biological domains (e.g. animals and plants) and a subordinate category of species varieties (e.g. particular breeds or strains). The generic species level is of particular importance. Membership in a generic species is associated with 'psychological essentialism' [42], the belief that members of a species share a causal essence or inner nature, which causes them to share the typical properties of that kind [39,43,44]. Psychological essentialism has been used to explain two findings about folkbiology. First, adults believe that membership in a species is inherited by descent and is not affected by interventions that affect the observable properties of an individual. Second, adults believe that the development of species-typical traits does not depend on environmental influences. When asked to imagine a cow that has been raised by a family of pigs, adults assume that the cow will display the normal bovine traits (e.g. mooing instead of oinking [45,46]). Atran [47] has proposed that folkbiology has another core feature: the tendency to explain traits teleologically. That is, people tend to explain the traits possessed by animals and plants by asserting that these traits have a purpose, although this proposal remains controversial [48–50].

In our earlier work, we explored the idea that vernacular conceptions of behavioural development are applications of this folkbiological theory of 'animal natures'. Following Griffiths [51], we hypothesized that biologically naive adults believe that some observable properties of organisms are the expression of an organism's inner nature, and hence (i) are typical of the entire species (or some natural subset such as males or juveniles), (ii) do not depend on the particular environment in which the organism is raised and (iii) serve some purpose. We referred to these features of traits that express an organism's nature as 'Typicality', 'Fixity' and 'Teleology'. We conceived of these three features as broad themes that would manifest very differently in different cultures, just as cognitive anthropologists expect to find many different ethnotaxonomies, but in each of which it would be possible to identify similar structural themes. We hypothesized that these three features influence people's decision about the innateness of a given trait in an additive manner. That is, the Typicality, Fixity and Teleology of a given trait should make independent, positive contributions to the likelihood of judging that the trait is innate.

To test this hypothesis, we developed eight vignettes describing the song of eight different bird species (for details, see [52]). The vignettes systematically varied whether the trait was species-typical, whether its development was dependent on the environment and whether it was functional. Consistent with our hypothesis, we found that Typicality and Fixity significantly predicted the folk's judgments about innateness and that their influence on people's judgments was additive. In addition, teleology was a marginally significant predictor of these judgments. We interpreted our findings as showing that folk judgments about the innateness of this trait are influenced by its Typicality, its Fixity and possibly by its Teleology.

The new studies reported here have two aims. The first is to replicate the earlier studies with new vignettes developed with the aim of making them credible to scientists. This is because we plan in future work to compare different expert conceptions of behavioural development to the naive conception and to one another (§6). This necessitates having materials that scientists familiar with behavioural development regard as containing sufficient information upon which to base a judgement. The second aim was to move beyond studying innateness, as this is not the only concept in play in discussions of behavioural development. The new studies extend our work to vernacular conceptions of behaviour as 'in the DNA', arguably at least as important a part of twentieth-century folkbiology as innateness.

3. METHOD AND PARTICIPANTS

(a) Stimuli

To examine the robustness of the results reported in Griffiths *et al.* [52], which suggest that that Fixity, Typicality and (to a smaller extent) Teleology are additive factors positively affecting judgments of innateness, we developed a new set of probes. Like the ones used in Griffiths *et al.* [52], these new probes ask participants to make a judgement about the innateness of the birdsongs. However, in contrast to the original probes, which were formulated in a lay terminology, these new probes are formulated using more technical and accurate vocabulary.

The eight probes describing the examples of bird-song have the same structure. They start with one or two sentences naming one of eight different species of bird and provide some neutral information about each organism. This is designed to convince participants that they are evaluating the behaviour of real animals. The remainder of the probe states whether the song of the male of this species is Fixed, Typical, Teleological or their opposites, using one of each of these pairs of statements:

— Fixed/Plastic

0. It can be shown by experimentally manipulating what young birds hear that the sequence of song elements produced by an adult (species name) male depends on which sequences it hears when it is young.
1. It can be shown by experimentally manipulating what young birds hear that the sequence of song elements produced by an adult (species

name) male does not depend on which sequences it hears when it is young.

— Typical/~Typical

0. Studies have shown that there is significant inter-population and interindividual variation in the sequence of song elements produced by (species name) males.
1. Studies have shown that there is no significant inter-population and interindividual variation in the sequence of song elements produced by (species name) males.

— Teleology/~Teleology

0. Close observations of these birds reveal that the sequence of song elements produced by (species name) males does not help them to attract mates and does not help them to defend their territory. Scientists therefore agree that the sequence of song elements produced by (species name) males is not an adaptation.
1. Close observations of these birds reveal that the sequence of song elements produced by (species name) males helps them attract mates and helps them to defend their territory. Scientists therefore agree that the sequence of song elements produced by (species name) males is an adaptation.

The probes presented to participants were preceded by a paragraph of general information about birdsong research, designed to convince participants that there is a wealth of well-established scientific knowledge about this topic.

To illustrate, the probe describing a species of bird whose song is ~Typical, Plastic and ~Teleological reads as follows:

Sarkar's Sparrow (*Aimophila sarkarii*) is one of the many species of American sparrow. It is found in Mexico and southwest Texas. Historically, it was more widely distributed in the southwestern USA, but its range has contracted as a result of overgrazing by livestock. It can be shown by experimentally manipulating what young birds hear that the sequence of song elements produced by an adult Sarkar's Sparrow male depends on which sequences it hears when it is young. Furthermore, studies have shown that there is significant inter-population and interindividual variation in the sequence of song elements produced by Sarkar's Sparrow males. Finally, close observations of these birds reveal that the sequence of song elements produced by Sarkar's Sparrow males does not help them to attract mates and does not help them to defend their territory. Scientists therefore agree that the sequence of song elements produced by Sarkar's Sparrow males is not an adaptation.

The description of the birdsong was followed by one of three questions:

The sequence of song elements produced by a male [species name] is innate.

The sequence of song elements produced by a male [species name] is part of its nature.

The sequence of song elements produced by a male [species name] is in its DNA.

Each subject was asked only one of these questions and in each case they answered on a 7-point scale

anchored at '1' with 'strongly disagree' and '7' with 'strongly agree'.

The innateness question was designed to replicate our earlier results with the new vignettes. The other two questions were designed to examine whether 'in the DNA' and 'part of its nature' are mere synonyms of innate in contemporary English or rather whether they express the three themes of the folkbiological theory of development in their own distinctive way.

(b) Procedure and participants

We used a mixed design with Fixity as a between-participants factor and Typicality and Teleology as within-participants factors. Thus, each participant was presented with four probes, and participants could be assigned to one of six conditions (table 1):

To control for order effects, the order of the four probes within each condition was pseudo-randomized across participants according to the latin-square design.

In classroom settings, 379 individuals taking classes at the University of Sydney were randomly assigned to one of the six conditions. Eighty-five participants gave uniform answers to all the probes they were presented with, suggesting they did not take the survey seriously. These participants were removed from the dataset, resulting in a sample of 294 participants (46% males; age range: 18–58; mean: 21).

Participants also indicated age, gender, native-speaker status, education level in biology and in psychology, and general attitude to 'biological' explanations of human behaviour. To evaluate this last topic, we presented participants with the statement 'Much of human behaviour can be understood as part of our biological nature' followed by the 7-point scale described above. To analyse participants' answer to this question, we dichotomized our scale. Although participants who favoured biological over environmental explanations tended to agree more with the claim that songs were innate, part of the nature of the bird, or in its DNA, these effects were never significant, and this disposition did not interact with any of the three factors of interest. Because most participants (78.9%) had not taken any biology courses, we did not analyse the effect of participants' education level in biology on their answers. Finally, we found no meaningful relation between participants' education level in psychology and their answers (participants were classified into three different groups, no psychology courses (44%), a single psychology course (23.9%) and two or more courses (32.1%)). For these reasons, we neglect these three variables in the analyses presented below.

4. RESULTS

(a) Innateness

Ninety-seven participants (42% males; age range: 18–52; mean: 20.6) were assigned to conditions 1 and 2. Table 2 summarizes the results.

To analyse these data, we ran a mixed-design ANOVA with Fixity as a between-participants factor, and Typicality and Teleology as within-participants factors (figure 1). As expected, we found a main

Table 1. Experimental conditions.

condition	question	between-subject variable	within-subject variables
1	innate	Fixity 0	Typicality, Function
2	innate	Fixity 1	Typicality, Function
3	in its DNA	Fixity 0	Typicality, Function
4	in its DNA	Fixity 1	Typicality, Function
5	part of its nature	Fixity 0	Typicality, Function
6	part of its nature	Fixity 1	Typicality, Function

effect of Fixity (Fixed > Plastic, $F_{1,95} = 7.1$, $p = 0.009$, partial $\eta^2 = 0.07$) and Typicality (Typical > Atypical, $F_{1,95} = 9.1$, $p = 0.003$, partial $\eta^2 = 0.09$), but no effect of Teleology ($F_{1,95} > 0.6$). Importantly, for our purposes, there was no significant interaction.

Together, the two significant predictors explain a moderate proportion of the variance: 16 per cent.

(b) In its DNA

One hundred and nine participants (50% males; age range: 18–43; mean: 21.3) were assigned to conditions 3 and 4. Table 3 summarizes the results.

To analyse these data, we ran a mixed-design ANOVA with Fixity as a between-participants factor, and Typicality and Teleology as within-participants factors. As expected, we found a main effect of Typicality (Typical > Atypical, $F_{1,107} = 11.4$, $p = 0.001$, partial $\eta^2 = 0.1$), Teleology (Functional > Non-functional, $F_{1,107} = 61.8$, $p = 0.001$, partial $\eta^2 = 0.1$) and Fixity (Fixed > Plastic, $F_{1,107} = 320.6$, $p < 0.001$, partial $\eta^2 = 0.16$). Importantly, for our purposes, there was no significant interaction (figure 2).

Together, the three significant or marginally significant predictors explain a large proportion of the variance: 46 per cent.

(c) Part of its nature

Eighty-eight participants (44% males; age range: 18–58; mean: 21.00) were assigned to conditions 5 and 6. Table 4 summarizes the results.

To analyse these data, we ran a mixed-design ANOVA with Fixity as a between-participants factor, and Typicality and Teleology as within-participants factors. As expected, we found a main effect of Fixity (Fixed > Plastic, $F_{1,86} = 5.8$, $p = 0.02$, partial $\eta^2 = 0.06$), but neither Typicality ($F_{1,86} > 0.7$) nor Teleology ($F_{1,86} > 0.25$) were significant (figure 3). There was no significant interaction. The significant predictor explains only a small proportion of the variance: 6 per cent.

(d) Comparison of the three studies

To examine statistically whether Fixity, Typicality and Teleology have a different influence across our three studies, we ran a mixed-design ANOVA with Study

Table 2. Mean answers (and s.d.) for 'is innate'.

	Typical		Atypical	
	Functional	Non-functional	Functional	Non-functional
Fixed	4.7 (1.8)	4.9 (1.7)	4.1 (1.8)	4.7 (1.8)
Plastic	4.4 (1.6)	4.1 (1.5)	3.8 (1.7)	3.7 (1.7)

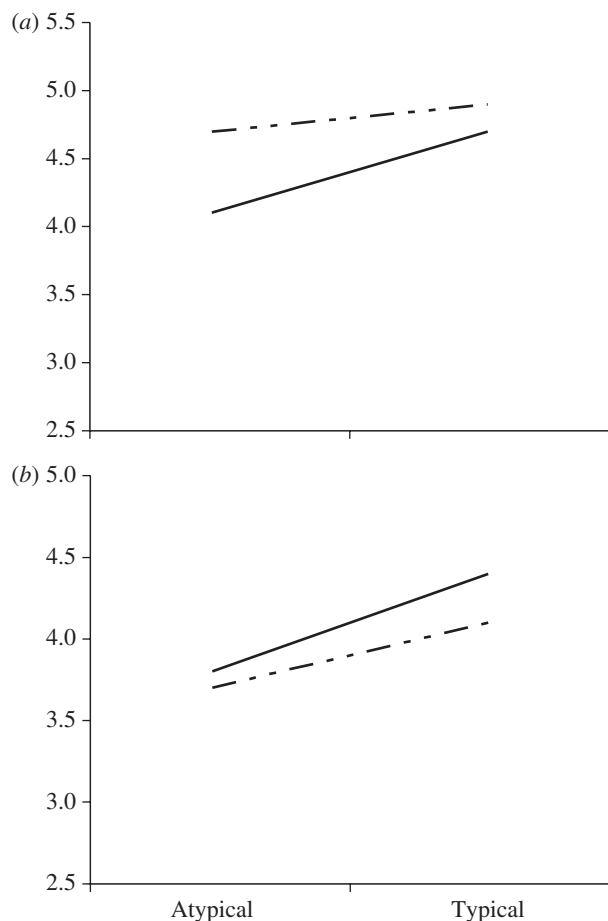


Figure 1. Mean responses to 'is innate' as a function of Typicality, Fixity and Teleology. (a) Fixed; (b) Plastic. Dashed-dotted line, Non-functional; solid line, Functional.

and Fixity as between-participants factors and Typicality and Teleology as within-participants factors. We were particularly interested in the interactions between our three factors and Study.

Fixity (Fixed > Plastic, $F_{1,288} = 29.4$, $p < 0.001$, partial $\eta^2 = 0.09$), Typicality (Typical > Atypical, $F_{1,288} = 14.0$, $p < 0.001$, partial $\eta^2 = 0.05$), Teleology (Functional > Non-functional, $F_{1,288} = 5.5$, $p = 0.03$, partial $\eta^2 = 0.02$) and Study ($F_{2,288} = 12.1$, $p < 0.001$, partial $\eta^2 = 0.08$) were all significant. More important, for our present purposes, the interaction between Study and Teleology was significant ($F_{2,288} = 3.9$, $p = 0.021$, partial $\eta^2 = 0.03$) and the interaction between Study and Typicality was marginally significant ($F_{2,288} = 2.4$, $p = 0.09$, partial $\eta^2 = 0.02$), suggesting that Teleology and possibly Typicality influence differently participants' answers in the three studies. In contrast, the interaction between Study and Fixity was not significant ($p > 0.4$), suggesting that fixity affects participants' answers similarly in the three studies.

These findings are evidence that innate, 'part of its nature' and 'in the DNA' are not merely synonymous in English.

5. DISCUSSION

The starting point for the series of studies reported here and in our earlier paper was the traditional philosophical project of analysing the concept of innateness. Placing this project in the context of the folkbiology literature led to a broader conception of its aim, namely investigating the folk-understanding of behavioural development. This involved treating concepts as structured mental representations used to process information about certain domains of phenomena [53]. This creates the possibility that the same folk theory and the conceptual structure associated with it can have several, different linguistic expressions. The results of the present studies support this perspective. Different linguistic items, specifically innate and 'in the DNA', appear to activate different aspects of an underlying folk theory of development.

Consider first the factors influencing folk judgments of innateness. Griffiths *et al.* [52] suggested that the concept of innateness was an additive combination of the three features of the folk theory of animal natures—Fixity, Typicality and Teleology. Teleology was included for two reasons. First, there is a plausible overlap in meaning between the phrases 'innate human traits' and human nature. Both of these expressions have strong normative overtones. The idea that human nature is how people are *meant* to be and no good can come of trying to fight against it is an intuitive one, and often features in ethical discussions. This normative perspective does not seem to be unique to *human* nature as the idea that non-human animals should be allowed to develop and to live in a way that reflects their inherent, natural tendencies is also intuitive. Second, several scientists and philosophers have suggested that innate should be analysed to mean 'designed by natural selection' [37].

However, in our initial between-subject study, Teleology did not have a significant effect on judgments of innateness, and in our initial within-subject study, it had only a small effect. Various possible deficits in our materials could explain these results (see Griffiths *et al.* [52] for discussion). In the present study of innateness, we have significantly revised those materials and in particular we reworked our initial operationalization of Teleology. Despite this, we obtained the same results on the innateness question. This could be interpreted as a falsification of our original hypothesis: contrary to our expectations, the folk theory of animal natures is not based on three additive factors. Instead, biologically naive subjects classify

Table 3. Mean answers (and s.d.) for 'in its DNA'.

	Typical		Atypical	
	Functional	Non-functional	Functional	Non-functional
Fixed	4.8 (1.8)	4.3 (1.6)	4.4 (1.9)	4.0 (1.6)
Plastic	4.3 (1.6)	3.3 (1.7)	3.7 (1.8)	2.8 (1.5)

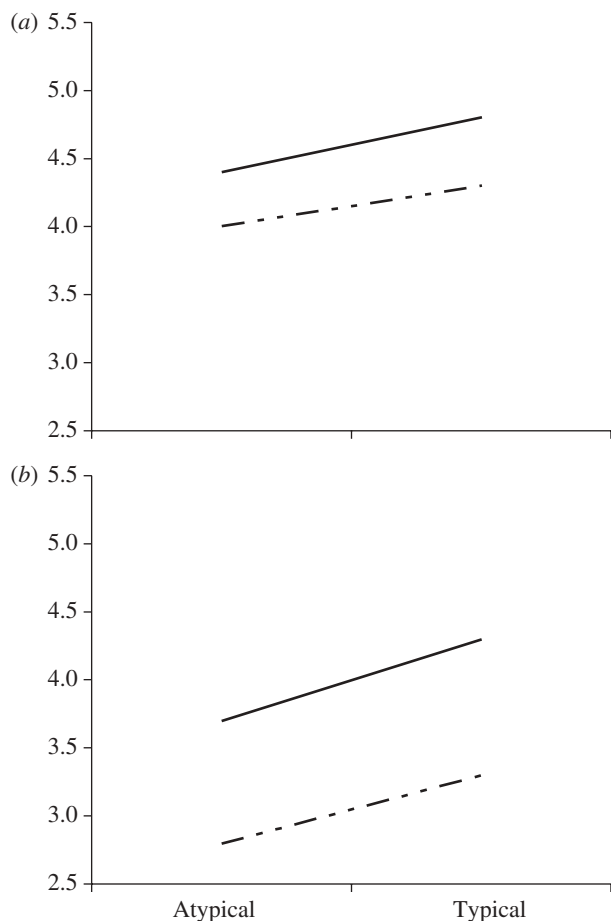


Figure 2. Mean answer to 'in its DNA' as a function of Typicality, Fixity and Teleology. (a) Fixed; (b) Plastic. Dashed–dotted line, Non-functional; solid line, Functional.

traits as a part of an organism's nature solely on the basis of information about Fixity and Typicality, with Fixity weighted more heavily than Typicality. However, an alternative interpretation is that the folk theory of animal natures is based on the three factors that we hypothesized, but that the term innate is not the preferred colloquial expression of this theory.

In support of this alternative, consider how subjects responded to the same vignettes when asked whether birdsong is 'in its DNA'. We chose this phrase as a way of probing the folkbiology of animal natures because of the ubiquity of this phrase and its close cognate 'in its genes' in contemporary culture. Where people might once have said that a person (or by metaphorical extension a company or political party) does something 'by instinct', they now often say it is 'in their DNA'. It therefore seemed likely to us that in 'in the DNA' would be a powerful idiomatic expression of biologically naive ideas about heredity and development.

This is indeed what our data suggest. When judging if a song is in a bird's DNA, subjects respond strongly to all three information items. For our subjects, 'in its DNA' seems to get to the heart of the folkbiology of animal natures. However little they may understand about genetics and molecular biology, the term 'DNA' expresses for them the idea that an animal has an unseen property derived from its parents that it shares with other members of its (folk-) species, and which explains why it develops species-typical properties, properties which the animal was designed to have.

The fact that young Australians in 2009 find this science-derived idiom a natural expression of folkbiology is not surprising. It is consistent with the finding in the earlier literature that folkbiological themes are mediated by local culture, to create a distinctive, local folk theory in which shared themes can be observed with other folkbiologies [39,54]. Whether the themes we have identified in contemporary Australian and North American folkbiology are actually widely shared, of course, cannot be determined without cross-cultural research.

The most surprising feature of our data is that Teleology is the second largest factor predicting judgments about whether a trait is in the DNA, in contrast to judgements of innateness where it has little, if any, influence. This suggests that Donald Symons may have been on the right track when he wrote:

... is it an adaptation? When people ask whether there are genes for trait X, this is the question whose answer they are usually seeking. Small wonder then, that they are perplexed when the useless, inevitably-affirmative answer to the ontogenetic question is palmed off on them, or they are told that the answer depends on the outcome of heritability studies!

([55], p. 141)

The results of asking whether the trait is 'part of its nature' were less interesting. Subjects showed a small response to information about Fixity, but otherwise answered randomly with respect to the information items. We suspect that explicit talk of 'natures' is not common in contemporary Australian English, except perhaps in the idiom 'human nature', and that the question was simply not meaningful to our undergraduate subjects. This emphasizes our broader conclusion that the way subjects responded to our information items was specific to the exact description that they were asked to apply to the behaviour.

6. FUTURE DIRECTIONS

We are currently attempting to study expert, scientific conceptions of innate behaviour. This work should shed light on some ongoing controversies about the innateness concept in the contemporary behavioural

Table 4. Mean responses (and s.d.) to 'part of its nature'.

	Typical		Atypical	
	Functional	Non-functional	Functional	Non-functional
Fixed	4.9 (1.6)	5.0 (1.6)	4.9 (1.7)	4.8 (1.5)
Plastic	4.7 (1.7)	4.1 (1.7)	4.5 (1.6)	4.3 (1.6)

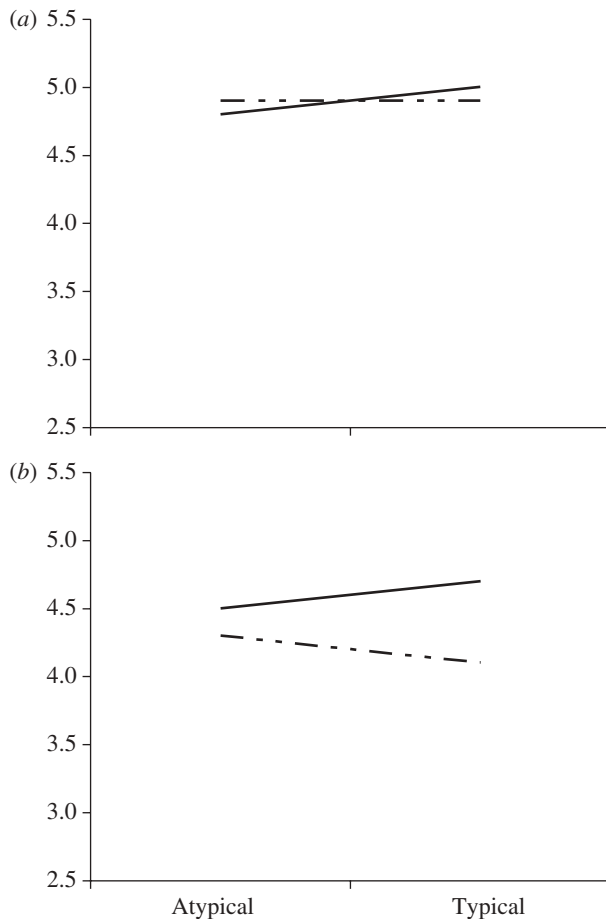


Figure 3. Mean responses to 'part of its nature' as a function of Typicality, Fixity and Teleology. (a) Fixed; (b) Plastic. Dashed-dotted line, Non-functional; solid line, Functional.

sciences. Several authors have suggested that the innate/acquired distinction is no longer of any scientific value [51,56–58]. On this view, the innateness category is so burdened by misleading implications that it should be eliminated from scientific discourse.

Opponents of this position argue that elimination is premature. They admit that the vernacular concept is misleading in certain respects, for instance, in its implication that developmental fixity is a discrete (all or nothing) property [59,60]. However, anti-eliminativists propose that a revised heir to this concept should be retained because it plays an integral role in the psychological sciences [60–63]. We agree that the fact that scientists use a particular construct is *prima facie* evidence that it is useful, but it is hardly definitive evidence. The history of science is littered with constructs that, looking back, can be seen to have been more of a hindrance than a help.

Progress in this debate has been hampered by both empirical and semantic obstacles. Empirically, there has been no systematic investigation of the ways that scientists understand innateness. It is unlikely that the term innate is used univocally across different disciplines. Hence, the idea of defining one revised notion of innateness for use in 'science' or even just 'psychology' may be misguided. If different disciplines use, and need to use, different constructs, then calling them all by the same name is a recipe for confusion. A related, semantic issue concerns the individuation of these concepts. What exactly is the difference between eliminating the concept of innateness from science and retaining some revised version of this concept? In order for this to be a substantive debate, there must be some more precise means of individuating these constructs.

Our experimental approach to these issues aims to avoid both obstacles. Specifically, it identifies three axes (Fixity, Typicality and Teleology) along which different conceptions of innateness can be compared. Instead of asking whether scientific conceptions are the same or different from those of the folk or each other, we can consider precisely the dimensions along which those conceptions vary. Another advantage of this approach is that it enables us to determine which particular disciplines retain which particular elements of the vernacular conception.

We are currently preparing to compare the responses of our biologically naive subjects with those of experts from various disciplines within the biological and social sciences. Disciplines of particular interest include developmental psychology, behavioural genetics, neurobiology, behavioural ecology, anthropology, cognitive linguistics and evolutionary psychology. Our prediction is that the factors influencing expert judgments about whether a trait is innate or 'in the genes' will vary according to area of specialization. This prediction is partly an extrapolation of earlier work like that of Mameli & Bateson [37] and partly a theoretical prediction from the fact that these disciplines study distinct aspects of psychological development and evolution. We expect that the vernacular conception of innateness has been modified and adapted to the particular research questions addressed within each of these fields. A similar pattern has been found among experts working in different biological disciplines who vary in their conceptions of the gene [64].¹

7. IMPLICATIONS FOR UNDERSTANDING HUMAN EVOLUTION AND DIVERSITY

Researchers interested in behavioural diversity should find our results on the effects of Typicality of particular

interest. Judgements about whether a trait is innate and whether it is 'in the DNA' are both substantially affected by information about Typicality. This suggests that biologically naive audiences will find it harder to assimilate information about the evolution of polymorphic or developmentally plastic phenotypes, and when told that a trait is innate or that it has a genetic basis, they will tend to default to the assumption that the trait is species-typical.

Earlier we cited examples of prominent researchers who, despite their theoretical sophistication, occasionally lapsed into an outmoded view of human nature that associates being a product of natural selection, and a target of evolutionary explanation, with being independent of the developmental environment and being species-typical. Our current research potentially explains this tendency. Just as someone with a physics training retains the capacity to think in terms of folk-physics, and attribute the slowing of a projectile to its running out of impetus, even the most sophisticated students of human behaviour retain the vernacular conception of innateness and can fall back into that way of conceiving innate traits. In this, as in so many other areas of science, the price of clarity is eternal vigilance.

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ENDNOTE

¹Our prediction is also based partly on pilot data (unpublished) collected from undergraduate students. Biology majors showed a suggestive (but non-significant) difference from psychology majors in their assessments of whether particular birdsong vignettes qualified as innate. Such differences should be more pronounced among experts.

REFERENCES

- Bateson, P. P. G. 2004 Developmental plasticity and human health. *Nature* **430**, 419–421. (doi:10.1038/nature02725)
- Gluckman, P. D., Hanson, M. A., Spencer, H. G. & Bateson, P. P. G. 2005 Environmental influences during development and their later consequences for health and disease: implications for the interpretation of empirical studies. *Proc. R. Soc. B* **272**, 671–677. (doi:10.1098/rspb.2004.3001)
- Schlichting, C. D. & Pigliucci, M. 1998 *Phenotypic evolution: a reaction norm perspective*. Sunderland, MA: Sinauer.
- Sultan, S. 1992 Phenotypic plasticity and the neo-Darwinian legacy. *Evol. Trends Plants* **6**, 61–70.
- Sultan, S. 2000 Phenotypic plasticity for plant development, function and life history. *Trends Plant Sci.* **5**, 537–542. (doi:10.1016/S1360-1385(00)01797-0)
- Uller, T. 2008 Developmental plasticity and the evolution of parental effects. *Trends Ecol. Evol.* **23**, 432–438. (doi:10.1016/j.tree.2008.04.005)
- West-Eberhard, M. J. 2003 *Developmental plasticity and evolution*. Oxford, UK: Oxford University Press.
- Machery, E. 2008 A plea for human nature. *Phil. Psychol.* **21**, 321–329. (doi:10.1080/09515080802170119)
- Jablonka, E. & Lamb, M. 2005 *Evolution in four dimensions: genetic, epigenetic, behavioral, and symbolic variation in the history of life*. Cambridge, MA: MIT Press.
- Jablonka, E. & Raz, G. 2009 Transgenerational epigenetic inheritance: prevalence, mechanisms, and implications for the study of heredity and evolution. *Q. Rev. Biol.* **84**, 131–176. (doi:10.1086/598822)
- Oyama, S., Griffiths, P. E. & Gray, R. D. 2001 *Cycles of contingency: developmental systems and evolution*. Cambridge, MA: MIT Press.
- West, M. J. & King, A. P. 1987 Settling nature and nurture into an ontogenetic niche. *Dev. Psychobiol.* **20**, 549–562. (doi:10.1002/dev.420200508)
- Lieberman, D. 2009 Rethinking the Taiwanese minor marriage data: evidence the mind uses multiple kinship cues to regulate inbreeding avoidance. *Evol. Hum. Behav.* **28**, 211–213. (doi:10.1016/j.evolhumbehav.2007.02.001)
- Boesch, C. 2007 What makes us human (*Homo sapiens*)? The challenge of cognitive cross-species comparison. *J. Comp. Psychol.* **121**, 227–240. (doi:10.1037/0735-7036.121.3.227)
- Tooby, J. & Cosmides, L. 1992 The psychological foundations of culture. In *The adapted mind: evolutionary psychology and the generation of culture* (eds J. H. Barkow, L. Cosmides & J. Tooby), pp. 19–136. Oxford, UK: Oxford University Press.
- Griffiths, P. E. & Stotz, K. 2000 How the mind grows: a developmental perspective on the biology of cognition. *Synthese* **122**, 29–51. (doi:10.1023/A:1005215909498)
- Badyaev, A. V., Hill, G. E., Beck, M. L., Dervan, A. A., Duckworth, R. E. A., McGraw, K. J., Nolan, P. M. & Whittingham, L. A. 2002 Sex-biased hatching order and adaptive population divergence in a passerine bird. *Science* **295**, 316–318. (doi:10.1126/science.1066651)
- Pennisi, E. 2002 Finches adapt rapidly to new homes. *Science* **295**, 249–250. (doi:10.1126/science.295.5553.249a)
- Smith, E. A., Mulder, M. B. & Hill, K. 2001 Controversies in the evolutionary social sciences: a guide for the perplexed. *Trends Ecol. Evol.* **16**, 128–135. (doi:10.1016/S0169-5347(00)02077-2)
- Boyd, R. & Richerson, P. J. 1985 *Culture and the evolutionary process*. Chicago, IL: Chicago University Press.
- Richerson, P. J. & Boyd, R. 2005 *Not by genes alone: how culture transformed human evolution*. Chicago, IL: University of Chicago Press.
- Barrett, H. C. 2006 Modularity and design reincarnation. In *The innate mind: culture and cognition* (eds P. Carruthers & S. Laurence & S. Stich), pp. 199–217. New York, NY: Oxford University Press.
- Fessler, D. M. T. 2006 Steps toward the evolutionary psychology of a culture-dependent species. In *The innate mind: culture and cognition* (eds P. Carruthers, S. Laurence & S. Stich), pp. 61–77. New York, NY: Oxford University Press.
- Fessler, D. M. T. & Machery, E. In press. Culture and cognition. In *Oxford handbook of philosophy and cognitive science* (eds E. Margolis, R. Samules & S. P. Stich). Oxford, UK: Oxford University Press.
- Bierhoff, H. W. 2002 *Prosocial behavior*. New York, NY: Taylor and Francis.
- Fehr, E. & Gächter, S. 2003 The puzzle of human cooperation: reply. *Nature* **421**, 912. (doi:10.1038/421912a)

- 27 Johnson, J. M. et al. 2003 Genome-wide survey of human alternative pre-mRNA splicing with exon junction microarrays. *Science* **302**, 2141–2144. (doi:10.1126/science.1090100)
- 28 Brosnan, S. F. 2006 Nonhuman species' reactions to inequity and their implications for fairness. *Soc. Justice Res.* **19**, 153–185. (doi:10.1007/s11211-006-0002-z)
- 29 Haidt, J. & Joseph, C. 2004 Intuitive ethics: how innately prepared intuitions generate culturally variable virtues. *Daedalus* **133**, 55–66. (doi:10.1162/0011526042365555)
- 30 Millar, M. G. 2009 Implicit associations with social status: the effects of relationship involvement. *Evol. Hum. Behav.* **30**, 356–362. (doi:10.1016/j.evolhumbehav.2009.05.002)
- 31 Hinde, R. A. 1968 Dichotomies in the study of development. In *Genetic and environmental influences on behaviour* (eds J. M. Thoday & A. S. Parkes). New York, NY: Plenum.
- 32 Lehrman, D. S. 1953 Critique of Konrad Lorenz's theory of instinctive behavior. *Q. Rev. Biol.* **28**, 337–363. (doi:10.1086/399858)
- 33 Tinbergen, N. 1963 On the aims and methods of ethology. *Zeitschr. Tierpsychol.* **20**, 410–433. (doi:10.1111/j.1439-0310.1963.tb01161.x)
- 34 West, M. J., King, A. P. & Duff, M. A. 1990 Communicating about communicating: when innate is not enough. *Dev. Psychobiol.* **23**, 585–598. (doi:10.1002/dev.420230705)
- 35 Griffiths, P. E. 2009 The distinction between innate and acquired characteristics. In *Stanford encyclopedia of philosophy* (ed. E. N. Zalta), Stanford, CA: Metaphysics Research Laboratory, Stanford University.
- 36 Carruthers, P., Laurence, S. & Stich, S. 2005–2009 *The innate mind*, vol. 1–3. Oxford, UK: Oxford University Press.
- 37 Mameli, M. & Bateson, P. P. G. 2006 Innateness and the sciences. *Biol. Phil.* **22**, 155–188. (doi:10.1007/s10539-005-5144-0)
- 38 Clement, J. 1983 A conceptual model discussed by Galileo and used intuitively by physics student. In *Mental models* (eds D. Gentner & A. L. Stevens), pp. 325–345. Hillsdale, NJ: Erlbaum.
- 39 Atran, S. 1990 *Cognitive foundations of natural history: towards an anthropology of science*. Cambridge, UK: Cambridge University Press.
- 40 Berlin, B. 1992 *Ethnobiological classification*. Princeton, NJ: Princeton University Press.
- 41 Berlin, B., Breedlove, D. E. & Raven, P. H. 1973 General principles of classification and nomenclature in folk biology. *Am. Anthropol.* **74**, 214–242. (doi:10.1525/aa.1973.75.1.02a00140)
- 42 Medin, D. & Atran, S. 2004 The native mind: biological categorization and reasoning in development and across cultures. *Psychol. Rev.* **111**, 960–983. (doi:10.1037/0033-295X.111.4.960)
- 43 Gelman, S. 2003 *The essential child: origins of essentialism in everyday thought*. New York, NY: Oxford University Press.
- 44 Medin, D. & Ortony, A. 1989 Psychological essentialism. In *Similarity and analogical reasoning* (eds S. Vosniadou & A. Ortony). Cambridge, UK: Cambridge University Press.
- 45 Atran, S., Medin, D., Lynch, E., Vaparansky, V., Edilberto, U. E. & Sousa, P. 2001 Folkbiology doesn't come from folkpsychology: evidence from Yukatek Maya in cross-cultural perspective. *J. Cogn. Cult.* **1**, 3–42. (doi:10.1163/156853701300063561)
- 46 Sousa, P., Atran, S. & Medin, D. 2002 Essentialism and folkbiology: further evidence from Brazil. *J. Cogn. Cult.* **2**, 195–223. (doi:10.1163/15685370260225099)
- 47 Atran, S. 1995 Causal constraints on categories and categorical constraints on biological reasoning across cultures. In *Causal cognition: a multi-disciplinary debate* (eds D. Sperber, D. Premack & A. J. Premack), pp. 205–233. Oxford, UK: Clarendon Press.
- 48 Gelman, S. & Hirschfeld, L. A. 1999 How biological is essentialism? In *Folkbiology* (eds D. L. Medin & S. Artan), pp. 403–446. Cambridge, MA: MIT Press.
- 49 Kelemen, D. 1999 Functions, goals and intentions: children's teleological reasoning about objects. *Trends Cogn. Sci.* **12**, 461–468. (doi:10.1016/S1364-6613(99)01402-3)
- 50 Kelemen, D. 2004 Are children 'intuitive theists'? Reasoning about purpose and design in nature. *Psychol. Sci.* **15**, 295–301. (doi:10.1111/j.0956-7976.2004.00672.x)
- 51 Griffiths, P. E. 2002 What is innateness? *The Monist* **85**, 70–85.
- 52 Griffiths, P. E., Machery, E. & Linquist, S. 2009 The vernacular concept of innateness. *Mind Lang.* **24**, 605–630. (doi:10.1111/j.1468-0017.2009.01376.x)
- 53 Machery, E. 2009 *Doing without concepts*. New York, NY: Oxford University Press.
- 54 Medin, D. & Atran, S. 1999 *Folkbiology*. Cambridge, MA: MIT Press.
- 55 Symons, D. 1992 On the use and misuse of Darwinism in the study of human behavior. In *The adapted mind: evolutionary psychology and the generation of culture* (eds J. H. Barkow, L. Cosmides & J. Tooby), pp. 137–161. Oxford, UK: Oxford University Press.
- 56 Bateson, P. P. G. 1991 Are there principles of behavioural development? In *The development and integration of behaviour: essays in honour of Robert Hinde* (ed. P. P. G. Bateson), pp. 19–39. Cambridge, MA: Cambridge University Press.
- 57 Griffiths, P. E. & Machery, E. 2008 Innateness, canalisation and 'biologizing the mind'. *Phil. Psychol.* **21**, 397–414. (doi:10.1080/09515080802201146)
- 58 Stotz, K. 2008 The ingredients for a postgenomic synthesis of nature and nurture. *Phil. Psychol.* **21**, 359–381. (doi:10.1080/09515080802200981)
- 59 Ariew, A. 1999 Innateness is canalization: in defense of a developmental account of innateness. In *Where biology meets psychology: philosophical essays* (ed. V. G. Hardcastle), pp. 117–138. Cambridge, MA: MIT Press.
- 60 Ariew, A. 2006 Innateness. In *Handbook of the philosophy of science: philosophy of biology* (eds M. Matthen & C. Stevens), pp. 567–584. Amsterdam, The Netherlands: Elsevier.
- 61 Khalidi, M. A. 2007 Innate cognitive capacities. *Mind Lang.* **22**, 92–115. (doi:10.1111/j.1468-0017.2006.00301.x)
- 62 Khalidi, M. A. 2009 Should we eliminate the innate? Reply to Griffiths and Machery. *Phil. Psychol.* **22**, 505–519. (doi:10.1080/09515080903153618)
- 63 Samuels, R. 2002 Nativism in cognitive science. *Mind Lang.* **17**, 233–265. (doi:10.1111/1468-0017.00197)
- 64 Stotz, K., Griffiths, P. & Knight, R. 2004 How scientists conceptualise genes: an empirical study. *Stud. Hist. Phil. Biol. Biomed. Sci.* **35**, 647–673. (doi:10.1016/j.shpsc.2004.09.005)