Has the innateness concept helped or hindered the understanding of behavioural and cognitive development?

PATRICK BATESON  
Sub-Department of Animal Behaviour  
University of Cambridge, High Street, Madingley  
Cambridge CB3 8AA, UK  
ppgb@cam.ac.uk

MATTEO MAMELI  
King’s College  
Cambridge CB2 1ST, UK  
gmm32@cam.ac.uk

Abstract  
The concept of innateness is a part of folk wisdom but is also used by biologists and cognitive scientists, albeit in various ways. The folk distinction between innate and non-innate traits is applied differently. While some of the proposed uses are clearly faulty, other proposals appeal to conceptual tools that are useful for studying biological development. These include the concepts of ‘Darwinian adaptation’, ‘not learned’ and ‘developmentally robust’. Since each of these notions captures an important aspect of the intuitive distinction between innate and non-innate traits, many authors have treated these notions as tracking properties that are strongly correlated with each other. The existence of these correlations is an empirical issue that has not been thoroughly investigated. If the correlations exist, then a fuzzy innate/non-innate distinction may survive and have a legitimate role in science. We are sceptical, however, whether two categories of innate and not innate traits will be uncovered by such an investigation. We believe that the assumption that a dichotomy will be revealed hinders a deeper understanding of the development of behaviour and cognition.

Keywords: innateness, instinct, genes, learning, plasticity, development, canalization, adaptation, evolution, evolutionary psychology, generative entrenchment.

Introduction  
After intense discussion in the second half of the twentieth century, the terms “innate” and “instinct” largely disappeared from the vocabulary of behavioural biologists. The terms were thought to be too ambiguous and the dichotomy of innate/not-innate unhelpful in understanding the development of behaviour. However, some authors have argued that too much was thrown out (e.g. Marler, 2004)) and many contemporary cognitive and evolutionary psychologists seem to find utility in the concept of innateness. Undoubtedly the concepts of innateness and instinct are a part of the folk understanding of biology and psychology. Such folk wisdom is captured in dictionary definitions of “innate” such as this:

“Existing in a person (or organism) from birth; belonging to the original or essential constitution (of body or mind); inborn, native, natural; of qualities, principles, etc. (esp. mental); opposed to acquired, esp. in innate ideas” (from the Oxford English Dictionary).

A widely held view is that some traits of an organism are due (either entirely or to a large extent) to the organism’s inborn nature and others are not. Cognitive scientists and anthropologists have started studying this folk distinction (Carey, 1985; Atran, 1990; Carey & Gelman 1991; Atran, Medin, Lynch, Vapnarsky, Ucan Ek’ & Sousa, 2001). Even so, apart from its role in folk biology and folk psychology, the innate/not-innate distinction only has a legitimate role to play in scientific biology and scientific psychology if it relates to a coherent body of evidence and plays a positive role in the development of productive research programmes in these scientific disciplines.

We examined elsewhere many different candidates for the post of scientific successor of the folk concept of innateness and argued that none of these candidates is entirely satisfactory (Mameli & Bateson, 2006). In some cases, this is because the proposals to which the candidates make reference are inchoate, empty or refer to other controversial notions. In other cases, it is because the overlap between the folk concept and the candidate successor is, at best, only partial. We suggested, therefore, that no simple correspondence between the folk concept and a scientifically useful
definition could be found. Nonetheless, it is worth examining those candidates that might be melded into a scientifically useful concept for understanding the origins and development of behaviour and cognition.

In what follows, we shall discuss scientific notions that have to do with the genetic origins of traits, scientific notions that have to do with the evolutionary origins of traits, scientific notions that have to do with the role of learning (or lack thereof) in development, and scientific notions that have to do with developmental robustness. Different scientifically useful concepts seem to capture different aspects of the folk understanding of innateness. One very important question concerns whether these concepts track a single biological or psychological phenomenon or whether they track properties that are often dissociated from each other. We shall address this question in the final section.

Genetic origins

Many authors writing today suppose that innateness has something to do with genes (e.g. Tooby & Cosmides, 1992; Plotkin, 1997; Chomsky, 2000; Fodor, 2001; Pinker, 2002; Miller, 2000; Baron-Cohen, 2003; Buss, 2003; Marcus, 2003; Marler, 2004). More often than not, this usage is based on loose ways of thinking about the role of genes in developmental processes. To argue, for instance, that a phenotype is innate if and only if genes and nothing but genes are required for its development is too simplistic. No phenotype is such that only genes are needed for its development, since an interplay between the developing organism and its environment is required at all stages of development. An alternative formulation that a trait is innate if and only if it is genetically influenced is equally naïve, but for the opposite reason. All phenotypes are genetically influenced because genes participate (one way or another) to the development of all phenotypes.

A more satisfactory formulation would be that innate traits are influenced distinctively by genes, in ways that non-innate traits are not. The problem is then to specify what this distinctive way might be. One proposal states that, even if non-genetic factors are necessary for development, an innate trait is one that is fixed by the genome, in the sense that non-genetic differences are not and cannot be responsible for differences in the trait. But, again, there are no such traits. For example, microgravity studies suggest that the value of gravitational acceleration can make a difference with respect to musculoskeletal structure (Klein-Nulend et al., 2003). If a woman grew up on a planet with moon-like acceleration of gravity, she would not necessarily die, but her muscles and bones would not be the species-typical ones observed on Earth. It is likely that, for every phenotype, some environmental factor can be found such that changes in this factor produce changes in the phenotype (rather than just the death of the organism). In fact, this would be expected on the assumption that the environment does not just provide the energy and matter required by developmental processes, but is also partly responsible for which nuclear genes are switched on and off and for the way the products of cellular transcription and translation are processed and used (Lewontin, 2000; Gilbert, 2001; Moore, 2001; Gottlieb, 2003; Meaney, 2003).

A different and popular proposal appeals to the alleged informational properties of genes. The innate character is supposedly encoded in the genes in the sense that all the information required for its development is contained in genomic sequences. This proposal distinguishes between factors that provide developmental information and factors that do not. Environmental factors are always involved (one way or another) in the development of phenotypes but, in the case of innate phenotypes, the assumption is that environmental factors only play a non-informational role.

The notion of genetic coding is perfectly legitimate when referring to the mapping between nucleotide sequences and proteins (or more strictly poly-peptides), because in this case it is easy to identify the code-like relation. It is much more difficult to substantiate the claim that the mapping between genes and phenotypes is informational (Godfrey-Smith, 2000). Genes might be seen either as representing the phenotypes to which they causally contribute and with which they are statistically correlated (Dawkins, 1982; Sterelny & Kitcher, 1988)). Or they might be seen as representing those phenotypes for the development of which they have been selected in the course of biological evolution (Dawkins, 1996; Maynard Smith, 2000; Sterelny, Smith & Dickison, 1996). The first view side-steps the issue of the many non-genetic differences that cause and are correlated with phenotypic differences. The second view side-steps the issue of the many non-genetic factors that have been selected for contributing to the development of phenotypes (Griffiths & Gray, 2001). In the absence of a good account of the general notion of genetic information, identifying innateness with the genetic coding of phenotypes is unlikely to succeed.

A related proposal is that a trait is innate if and only if its development does not involve the extraction of information from the environment. This proposal replaces the notion of genetic information with one of environmental information. The formulation seems to capture the notion of innateness implicit in Chomsky’s influential use of poverty of the stimulus arguments. On Chomsky’s account, human children cannot extract information about what are the permissible syntactic rules (in terms of human natural languages) from their linguistic environment and thereby syntactic knowledge must be innate (Chomsky, 1959, 2000; Cowie, 1999; Fodor, 2000; Khalidi, 2002). Chomsky often mentions ‘genetic determination’ and ‘genetic endowment’ when talking about the innateness of the language faculty (e.g. Chomsky, 2000). The assumption seems to be that if the information about syntactic structures is not extracted from the linguistic stimulus, then it must be extracted from the genome. But none of his arguments depends on such an account that equates innateness with genetic determination or genetic information. Given the actual nature of his
arguments, it seems more useful to reconstruct Chomsky’s view of innateness in terms of what knowledge can and
cannot be acquired by interacting with the environment.

In spite of this clarification, this proposal remains problematic for two reasons. First, just like for the notion of genetic
ingformation, no one has been able to provide a good explicit account of the notion of environmental information (with
respect to developmental processes) (see Oyama 1985). Second, even if the claim for such a thing as extractable
environmental information is accepted, it is not easy to draw a sharp distinction between acquisition processes that
involve an informational interaction with the environment and acquisition processes that do not (see Bateson, 1976).
Thus, the notion of information extraction from the environment is unlikely to provide the basis for a useful scientific
distinction between innate and non-innate traits.

A different approach to making scientific sense of innateness in terms of that which is taken from parents is to argue
that a trait is innate if and only if it is highly heritable. This approach appeals to the intuitive connection between the
idea that a trait is innate and the idea that the same trait is ‘hereditary’. In scientific parlance, heritability is a statistical
concept that applies to the variation for a phenotypic trait existing in a given population at a given time. In truth,
heritability is not a single concept but a family of related concepts. **Broad heritability** is defined as the ratio of the
variance of the phenotype due to genetic variation to the total variance of the phenotype in the population. That is, a
trait has high broad heritability in a population to the extent that the existing variation for that trait in the population is
due to genetic variation. **Narrow heritability** gives the extent that the existing variation for the phenotype is due to
variation in genes considered independently of their interactions with other genes at the same or at different loci.
**Selectional heritability** measures the phenotype’s response to selection relative to the intensity of the selection pressure.
**Covariational heritability** measures the strength of the correlation between close relatives for the phenotype in the
population under study. In some contexts, the differences between these various notions of heritability are important
(Falconer & Mackay, 1996; Mameli, 2004). For purposes of present discussion, we shall focus on broad heritability,
but the arguments we present can be easily generalised to the other notions of heritability.

If variance in a trait is entirely due to genetic variance, broad heritability is 1.0; if it is entirely due to variance in non-
genetic factors, broad heritability is 0.0. Many problems exist with the view that innateness can be identified with high
broad heritability. If innateness is high broad heritability, invariant phenotypes cannot be innate. So, on this proposal, in
a human population where all individuals are capable of acquiring language, being able to acquire language is not
innate. The view that innateness is the same as high broad heritability requires not only that some variation exists, but
also that this variation is due almost entirely to genetic differences. So, on this proposal, in a human population where
all individuals are able to acquire language except for a few individuals affected by some non-genetic disease or by
accident, the ability to acquire language is not innate. More generally, the problem with this proposal is that it makes
the innateness of a trait of a particular organism depend on the composition of the population to which that organism
belongs. Changes in the population can change the heritability (and, thereby, on this view, the innateness) of the traits
of an organism, despite the fact that all the properties of any one individual are the same.

It is perfectly possible for a trait to be highly heritable in the population but also learned by each individual within it. If
high heritability is compatible with learning, then high heritability is incompatible with the colloquial usage of
innateness. In general, heritability estimates provide only extremely poor information about developmental processes
(Lehrman, 1970; Lewontin, 1974; Bateson & Martin, 1999; (Lehrman, 1970); Gottlieb, 2003; Meaney, 2003).
Developmental robustness is another feature usually associated with innateness. But contrary to some common
misinterpretations of heritability estimates (Hermstein & Murray, 1994), the high heritability of a trait does not usually
support the hypothesis that the trait is developmentally robust.

Even if it does not (at least not by itself) provide a useful way to make scientific sense of innate/non-innate distinction,
the population language that associates a genetic difference with a phenotypic difference is certainly an important way
of operationalising the link between genes and behaviour (Jensen 1961; Hinde, 1969; Cassidy 1979; Jacobs 1981) and
is central in debates about biological evolution. The question that we shall now address is whether the approach of the
population geneticists to evolutionary biology can help in relation to the concept of innateness.

**Evolutionary origins**

The idea that natural selection and innateness are somehow related is a popular and powerful idea (Johnston, 2001).
Attempts to relate innateness to natural selection go back to Darwin himself. Darwin used the word “innate” as
synonymous with “inherited” and he used “instinct” as synonymous with “inherited behaviour” (Darwin, 1859, 1871,
1872), although he wisely refused to give explicit definitions. What does “inherited” mean in this context? The view
implicit in Darwin’s writings is that some privileged material that determines the development of certain traits—
including behavioural traits—is transferred from parents to offspring at the moment of conception. These traits are the
biologically inherited or instinctive ones; all other traits are said to be “acquired”. This was not just Darwin’s view; it
was the received view. What Darwin famously and importantly added was the proposal that inherited traits can evolve
by a process of differential survival and reproduction. When the results of Mendel’s breeding experiments were
rediscovered and the science of genetics started in earnest, genes were identified with those entities that are transmitted.
from parents to offspring at conception and are responsible for the development of the inherited traits. This
deterministic account of the trans-generational stability of phenotypic form was and still is extremely popular. But we
now know that this account is undermined by developmental studies showing the highly interactive nature of
developmental processes, including the development of those traits that exhibit Mendelian inheritance (Oyama, 1985;
Bateson, 1983).

Attempts have been made to relate innateness to natural selection without an appeal to deterministic views of
development. The most common proposal is that a trait is to be counted as innate if and only if it is a product of natural
selection. In Symons' (1992, p. 141) words: “The question whether a trait is ‘in our genes’ can be construed as a
question about whether the trait is a Darwinian adaptation”. One famous version of this proposal can be found in
Lorenz (1965). Lorenz’s earlier views about instinct had been sharply and influentially criticised by Lehrman (1953), reformulated the innate/non-innate distinction in terms of adaptive information stored in the genome by the
process of natural selection and adaptive information extracted from the environment. He wrote:

“No biologist in his right senses will forget that the blueprint contained in the genome requires innumerable
environmental factors in order to be realised in the phenogeny of structures and functions. During his individual
growth, the male stickleback may need water of sufficient oxygen content, copepods for food, light, detailed pictures
on his retina, and millions of other conditions in order to enable him, as an adult, to respond selectively to the red belly
of a rival. Whatever wonders phenogeny may perform, however, it cannot extract from these factors information which
simply is not contained in them, namely, the information that a rival is red underneath.” (Lorenz, 1965, p. 37)

One thing to notice is the similarity between Lorenz’s views and Chomsky’s views about genetic versus environmental
sources of information. The difference between the two authors lies mainly in the fact that Lorenz formulated his
theory by appealing to the theory of natural selection, while Chomsky did not. Both Lorenz and Chomsky saw a clear-cut distinction between experiences that produce their effects on behaviour through learning and experiences that are
required for normal development and, when withheld, damage the animal in some way. Unfortunately, this distinction is
not as clear-cut as they thought. The difficulty of finding a coherent way to distinguish ‘experiences’ that provide mere developmental support from ‘experiences’ that provide information was stressed by Lehrman (1970). In some
cases specific experiences are required for the development of a particular trait, in other cases non-specific experiences
are required, and many cases fall in between these two extremes. It is a continuum and, for this reason, the dichotomous
distinction of environment-as-information vs. environment-as-support cannot adequately capture the reality of
biological phenomena (Bateson, 1976). This is one of the most important problems facing anyone who wants to give an
account of the notion of environmental information.

An important issue in relation to the Lorenz’s proposal of defining innateness in terms of Darwinian adaptation is
whether behaviour can be so neatly categorised into examples that are adapted during biological evolution and those
that are not. What about the case where both phylogenetic and ontogenetic adaptation take place as in the pecking
responses of gulls (Hailman, 1957) or the smiling of human infants (Bateson & Martin, 1999)? A desire to resurrect the
old dichotomy is detectable in Lorenz (1965). He wrote: “I strongly doubt that the motor co-ordination of
phylogenetically adapted motor patterns are at all modifiable by learning” (p.71). He was clearly still thinking in terms
of his old notion of the “intercalation” of inborn and learned components of behaviour. This idea of “instinct-learning
intercalation” was pursued by Eibl-Eibesfeldt (1970) who argued strongly against the view that blended intermediates
constitute the majority of behaviour patterns. Among other examples, he cited his own study of nut-opening by
squirrels in which a complex sequence can, he claimed, be analyzed into components some of which are learned and
some of which are thought to develop without specific opportunities for practice. It seems unlikely that this will be the
rule, since so much of behavioural development of perceptual and motor processes involves the fine-tuning of
mechanisms that are in all probability the result of Darwinian evolution (Bateson, 2000).

A more general issue in relation to the attempt of equating innateness with Darwinian adaptation concerns the fact that
natural selection acts upon heritable variation in fitness, but the heritable variation need not be of genetic origin
(Griffiths & Gray, 1994; Mameli, 2004). A Darwinian adaptation is simply a phenotype that has increased in frequency
within a population because of Darwinian selection for this phenotype (Sober, 1984). This means that a Darwinian
adaptation can be generated by natural selection operating on genetic variation, on non-genetic variation, or on both. As
Lehrman (1970) put it, “nature selects for outcomes” (p. 28), and nature can select for an outcome that either requires
or does not require learning. Thus, a Darwinian adaptation can be a learned trait, and learning is usually considered to
be incompatible with innateness. A different point is that if innateness is equivalent with being a Darwinian adaptation
then the by-products of Darwinian adaptations (the evolutionary spandrels of Gould & Lewontin, 1979), genetic
diseases, and the phenotypic effects of new genetic mutations cannot be classified as innate.

Given these problems, Hogan (1994) suggested that the Lorenzian distinction be reformulated in terms of the notion of
prefunctionality. A trait is prefunctional if it appears in development ready to serve its apparent adaptive function
before it can do so or before having been tried and adjusted to do so. An example would be a component of preening
found in mallard ducklings. The component is identical to the behaviour of an adult mallard spreading the oil secreted
by the preen gland above their tail onto its feathers. The difference is simply that the ducklings perform this behaviour
weeks before their preen glands start to produce oil (Sandilands et al 2004) One difficulty with this proposal is that, as
Hogan himself points out, the same trait can have different functions and, thereby, it may count as prefunctional with respect to one function but not with respect to another. Moreover, traits affected by perceptual or social learning can be prefunctional.

A different approach is one with which Lorenz himself was very much involved, namely the comparative approach to behaviour and the emphasis on similarities in behaviour of members of the same taxonomic group. Behavioural similarities and differences could, Lorenz (1941) argued, be used to classify species. The same approach is implicit when modern writers examine patterns of behaviour that are characteristic of a species. This seems to be the view of innateness that motivates talk about “universal human nature” or “the psychic unity of humankind” (e.g. Tooby & Cosmides, 1992; Pinker, 2002; Buss, 2003; Gander, 2003). Species-typical features, it is argued, are those that result from the operation of natural selection and, as such, are usually innate. The same argument is often applied to some genetically-defined sub-population, such as one of the sexes or all the individuals that possess an abnormal genetic element (Baron-Cohen, 2003). However, traits that are typical in a species or in a sub-population can obviously be learned. One example is the social attachment that many birds and mammals have for their own kind (Bateson, 2000). All normal individuals have such an attachment under natural conditions, but they all acquire this attachment through their social experience. That is, species-typical traits may be learned and thereby species-typicality is an implausible defining criterion of innateness. The fact that a trait is common in a given species or in a genetically-defined sub-population within a species may in some circumstances be a symptom of lack of learning. But the association between typicality and lack of learning is context specific and should not thereby be taken for granted. The same applies to the association between species-typicality and developmental robustness.

Non-involvement of learning

The opposite of innate is often referred to as ‘acquired’. However, on a minimal understanding of acquisition, a trait is acquired by an organism if at first the organism does not have the trait and then, at some subsequent time, the organism comes to have the trait (Samuels, 2002). If so, all phenotypes are acquired. The only non-acquired traits would be those that the organism has from the very beginning of its existence, such as the nuclear genes and the cytoplasmic factors present in its zygote. A more specific way of thinking about acquisition is needed, such as ‘acquisition due to learning’, ‘acquisition due to experience’, or perhaps ‘acquisition due to the interaction with the environment’. One difficulty in this area is that learning is itself a theoretically controversial and heterogeneous notion, variously regarded as: any change in a brain network due to stimuli generated in the sensory apparatus by the interaction between the external environment and the sensory organs, associative learning (classical conditioning and operant conditioning), hypothesis testing, parameter setting, etc. The relations between the different views of learning are far from clear, and often display inconsistencies. For example, Quartz & Sejnowski (1997) argued that many characteristics of neural structures count as not learned on the view that learning is hypothesis testing and count as learned on the view that learning is a change in neural structures due to perceptual processing.

Samuels (2004) believed that the connection between ‘innate’ and ‘not learned’ is fundamental but that defining ‘innate’ as ‘not learned’ is too simplistic. He suggested that a trait is innate if and only if (i) the development of the trait is not explainable in psychological (as opposed to neurological, chemical, or physical) terms and (ii) the trait results from normal development. A first difficulty with this account is one that Samuels himself recognized, namely that no explanation of what counts as normal development is given. Defining innateness in terms of normal development without a clear definition of normal development may turn out to be the trading of one inchoate notion for another. A second difficulty is that the distinction between psychological explanations and non-psychological explanations is fuzzy and it seems to depend more on arbitrary disciplinary boundaries than on matters of fact. For example, Fodor, J. (1981) believed that the developmental triggering of cognitive structures is not a psychological process because it is not a rational-causal process but rather a brute-causal process (and on these grounds he claimed that all triggered cognitive traits are innate). In contrast, many behavioural biologists believe that triggering involved in developmental plasticity is one of the many processes of psychobiological development and as such it counts as a psychological process. A third difficult with Samuels’s proposal is that this proposal relates only to cognitive traits. Any other form of variable phenotype dependent on developmental plasticity would be lumped in with innateness.

These difficulties could at first sight be avoided by replacing ‘learning’ with a more general notion. Learning mechanisms are only a subset of a larger set of mechanisms evolved to map different environmental circumstances onto different phenotypes, be they morphological, physiological, or behavioural phenotypes. Thus, one proposal would be to regard a trait as innate if and only if it is not produced by developmental mechanisms that are adapted to produce different traits in response to different environmental conditions. On this basis, however, the limbs that develop in thalidomide-bathed wombs and acquired sociopathy due to brain injury would be classified as innate. Such traits are not due to mechanisms adapted to map environmental differences onto phenotypic differences. No mechanism evolved to map the presence of thalidomide in the womb onto the production of abnormal limbs and no mechanism evolved to map brain injury onto abnormal cognitive/emotional dispositions. In order to avoid classifying these traits as innate, an appeal has to be made to normal development. These traits can be discounted by saying that they are “abnormal” in that
they do not appear in the course of “normal” development. But once again this proposal is incomplete if no account of normal development is given.

**Developmental robustness**

Innateness is often associated with non-malleability. Waddington recognised that many characteristics of organisms are buffered against perturbation during development. In his terms, they are developmentally canalized and he defined canalization as “the capacity [of development] to produce a particular definite end-result in spite of a certain variability both in the initial situation from which development starts and in the conditions met during its course” (Waddington, 1957). Ariew (1999) suggested that the concept of canalization can serve as the scientific successor to folk concept of innateness. Wimsatt (2001) used the notion of ‘generative entrenchment’ to make much the same point. His proposal is that a feature of an organism is generatively entrenched to the extent that the development and the functioning of other features of the organism causally depend on that feature. Canalization and generative entrenchment are related properties. If the development and proper functioning of many adaptive features depend on it, then the developmental processes required for the feature are likely to be robust.

An innate phenotype is often supposed to be one produced by a process that is difficult to disrupt (developmental non-malleability), and one that is difficult to modify once it has developed (post-developmental non-malleability). However, developmental and post-developmental robustness do not necessarily go together. A trait that is robust with respect to its development may not also be robust with respect to its continuance. Developmental malleability may be followed by non-malleability, as in many examples of alternative phenotypes found throughout the animal kingdom, including humans (Bateson et al., 2004). Conversely, developmental non-malleability may be followed by considerable malleability, as in the case of the human smile, which reliably appears in infants during the fifth or sixth week after birth and is successively greatly modified by social interactions and cultural influences.

A potentially interesting claim is that a trait is innate if and only if it is regularly expressed at a given stage of development. Etymology suggests that innate means “present at birth”. However, since colloquial usage also suggests that innate means “not learned” and prenatal learning is known to occur (DeCasper & Fifer 1980; Gottlieb 1997), presence at birth is an unsatisfactory definition. More plausibly, innateness could be applied to traits that are regularly expressed at a given stage of development. For instance, migratory birds that have been hand-reared start showing migratory restlessness at the times of year when they would naturally start to move away from their breeding grounds or return to them (Gwinner, 1996). Humans start to walk at about the age of one, talk at about the age of two and express many new patterns of behaviour at the onset of sexual maturity or immediately after the birth of their first child. The problem for this formulation is that regularity of expression in development may depend on consistently expressed features of the environment. Details of sexual and parental behaviour may well be affected by childhood experiences. Indeed, despite the regularities in developmental timing, many human traits may be due to learning (Sterelny, 2003). This shows, more generally, that developmental stability is compatible with (and sometimes is generated by) learning. As such, developmental stability—and thereby canalization—is not plausibly equated with innateness. The same applies to generative entrenchment. For example, in literate societies reading skills are generatively entrenched in the sense that many of the cognitive skills people acquire in these societies depend on the prior acquisition of reading skills, but the acquisition of these skills requires intense training.

**Conclusion**

The folk concept of innateness is significantly mismatched with the scientific concepts that are useful in understanding behavioural and cognitive development. Moreover, the scientifically useful concepts that capture some aspect of the common sense notion of innateness are not equivalent. Consider for example the concepts of ‘Darwinian adaptation’, ‘not-learned’ and ‘developmentally robust’. A Darwinian adaptation may involve learning; learning itself is a heterogeneous concept, and some phenotypes resulting from developmental plasticity might be regarded as not learned. Robust phenotypes may be the product of mechanisms for generating developmental plasticity (including learning) and they may become malleable at a later stage of development. A Darwinian adaptation is not necessarily developmentally robust, and a robust trait is not necessarily a Darwinian adaptation. In other words, these three concepts only partially overlap and the epistemic relations among them may be much weaker than is often assumed (Mameli & Bateson, 2006).

Scientists using the concept of innateness have tended to treat the various scientific notions that capture some aspect of the folk concept as equivalent to each other or at least as tracking properties that are strongly correlated with each other. The existence of these correlations should not to be taken for granted. Whether the properties are strongly correlated or not is an important empirical issue. Consequently, it is wise not to prejudge the issue and bundle these different scientifically useful notions together under the label ‘innateness’.
We can call ‘innateness property’ any property of phenotypic traits referred to by a scientifically useful concept that captures some important aspect of the folk concept of innateness. Innateness properties may tend, for each given trait, to be either all present or all absent. This tendency may be imperfect and yet real. Or they may cluster in some domains (e.g. behavioural traits in insects) but not in others (e.g. cognitive traits in humans). Or they may not cluster at all. If the innateness properties cluster, then a fuzzy dichotomy between innate and non-innate traits survives (see Fig. 1 in Mameli & Bateson, 2006). If they do not cluster, then the innate/non-innate dichotomy will die and will be replaced by many other distinctions, sometimes related and sometimes unrelated with each other.

We are sceptical whether a useful dichotomy between phenotypes that are innate and those that are not-innate will be found. This scepticism is not based on the assumption that all behavioural and cognitive systems develop in the same way. Our point is simply that we do not think that there are just two developmental processes. The triggering mechanisms involved in producing alternative phenotypes are unlikely to be similar to the many processes of learning which, in their turn, probably differ radically from each other. Furthermore, the processes involved in the development of some neurobiological systems are probably quite different from those that require plasticity and may be more akin to the development of an organ such as a kidney.

The outcome of development will often have involved interplay between different types of developmental systems. To take one well studied case, behavioural imprinting in birds involves at least three separate modules: analysis of incoming information, recognition of previously experienced input and execution of species-specific motor activities (Bateson & Horn, 1994). Each of the modules develops in a different way but all three modules are required for the bird to form a social attachment. The outcome of the overall developmental process requires the interplay between them. Such examples, we believe, are likely to be the rule rather than the exception in the development of behaviour and cognition.

In conclusion, over-used metaphors from engineering such as “hard-wiring” and genetic “programming” applied globally to the outcome of development fail to capture the character of the processes and invite the mistaken view that they can be contrasted with their opposites. We believe that a thorough investigation of developmental processes has been hindered by indiscriminate use of the label "innate". Its use encourages researchers to bundle together notions that should be distinguished from each other and to assume that important questions about development have already been fully answered, when in reality they have not.

References


