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Research

An evaluation of the concept of innateness

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The concept of innateness is often used in explanations and classifications of biological and cognitive traits. But does this concept have a legitimate role to play in contemporary scientific discourse? Empirical studies and theoretical developments have revealed that simple and intuitively appealing ways of classifying traits (e.g. genetically specified versus owing to the environment) are inadequate. They have also revealed a variety of scientifically interesting ways of classifying traits each of which captures some aspect of the innate/non-innate distinction. These include things such as whether a trait is canalized, whether it has a history of natural selection, whether it developed without learning or without a specific set of environmental triggers, whether it is causally correlated with the action of certain specific genes, etc. We offer an analogy: the term 'jade' was once thought to refer to a single natural kind; it was then discovered that it refers to two different chemical compounds, jadeite and nephrite. In the same way, we argue, researchers should recognize that 'innateness' refers not to a single natural kind but to a set of (possibly related) natural kinds. When this happens, it will be easier to progress in the field of biological and cognitive sciences.

Keywords: innateness; nativism; natural selection; canalization; genetic information; learning

1. INTRODUCTION

The concept of innateness is used extensively in various debates in the biological and cognitive sciences. These debates are often about whether some particular trait (of some particular kind of organism) is innate or not. People can be said to be nativists about a trait if they claim that the trait is innate, and they are anti-nativist about the trait if they claim that the trait is not innate. So, for example, Socrates in Plato's *Meno* is a nativist about our knowledge of the principles of geometry; Chomsky [1] is a nativist about our knowledge of 'universal grammar'; Pinker [2] is a nativist about many aspects of human cognition. For general mental ability (as measured by IQ), personality traits, sexual preferences, political preferences, moral attitudes, obesity, and much else, some authors have argued these human characteristics are innate, and some have argued they are not. We shall call these debates the 'nativist debates'. In order for these debates to make sense, both nativists and anti-nativists must assume that the concept of innateness is coherent and theoretically useful. However, in the light of what is currently known about the development and evolution of biological and psychological traits, it is not clear whether this is the case. In particular, it is not clear whether the concept of innateness refers to any single theoretically useful property [3–9].

Various accounts of the concept of innateness have been proposed, some of which will be considered below. Each of these accounts argues that the concept refers to a specific property of biological and psychological traits, but different accounts focus on different properties. This property may relate to the supposed genetic origins of a trait, or to its developmental robustness, or to lack of learning in the developmental process. All these accounts capture some particular aspect of the concept, but no account seems to be able to capture all the aspects of the concept. This suggests that perhaps the concept of innateness conflates different properties, properties that, according to best current biological and psychological knowledge, need to be kept distinct. Mameli [8] called this the *clutter hypothesis*.

In order to clarify this hypothesis of clutter, we offer an analogy. The term 'jade' was once thought to refer to a single chemical compound. It was then discovered that, in fact, the term refers to two different chemical compounds, jadeite and nephrite. So, from the point of view of the science of chemical compounds, we can say that 'jade' conflates two distinct natural kinds, jadeite and nephrite. In the same way, from the point of view of the biological and cognitive sciences, the term 'innateness' can be said to conflate a number of distinct properties of biological and cognitive traits.

In what follows, we first examine some accounts of the concept of innateness which claim that this concept refers to a single property of biological and psychological traits, and show that they are unsatisfactory. We then explain and provide some arguments for the Clutter Hypothesis and, in §7, we reject some important arguments against this hypothesis.

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2. INNATENESS AND THE ABSENCE OF LEARNING

Any satisfactory account of innateness should at least entail that innateness and the consequences of learning are incompatible: if a trait is innate then it is not learned and if it is learned then it is not innate. Samuels [10] called this the *minimal condition*, which any account of innateness must meet. Given the importance of this condition, it is not surprising that arguments for the view that a specific trait is innate are very often arguments aimed at showing that the trait in question could not possibly be the result of learning (cf. [11]).

Consider, for example, Chomsky's famous poverty of the stimulus argument for the innateness of our knowledge of the principles of universal grammar. Chomsky argues that (i) the speed and reliability with which children acquire the ability to understand and speak a human language (at least at the level of syntax), (ii) the impoverished nature of the linguistic stimulus that children receive, and (iii) the small impact that variation in the stimuli seem to have on variation in language acquisition, indicate that children do not acquire their knowledge of the (deep) rules of syntax through learning. Hence, such knowledge must be innate. The inference is that since 'it could not possibly be learned', therefore 'it is innate'.

Anti-nativists about language argue that Chomsky is wrong to think that knowledge of the (deep) rules of syntax could not possibly be learned [12]. But anti-nativists do not typically reject the inference from 'it could not possibly be learned' to 'it is innate'. They just reject the claim that the relevant trait could not possibly be learned. This shows that the minimal condition is common ground between nativists and anti-nativists: both agree that the consequences of learning and innateness are incompatible. Nevertheless, this common ground is not enough for a full account of the concept of innateness. The view that innateness is simply the property of developing without learning is unsatisfactory: many traits that develop without learning are paradigmatic cases of non-innateness. For example, in some reptiles, the sex of the individual is determined by the temperature at which the egg is incubated: eggs that are placed in an environment below a certain temperature give rise to one sex, while eggs that are placed in an environment above that temperature give rise to the other sex [13]. No process of learning is involved in such an inductive process. Yet, in creatures like these, the sex of the organism cannot be classified as having developed irrespective of the individual's experience.

Here is another example. Immunologists routinely distinguish between the innate and non-innate components of the immune system [14]. The so-called innate immune system provides immediate defence against infection. It comprises the cells and mechanisms that defend the host from infection by other organisms in a non-specific way. The non-innate (also known as *adaptive*) parts of the immune system are those that develop and change in response to specific instances of infection from specific pathogens [15]. Nevertheless, such components are not the result of learning processes, in the sense that they are not the result of the psychological processing of information acquired through the senses. This shows that 'innate' is not equivalent to 'not acquired through learning'.

Psychological learning mechanisms are a subset of a larger class of mechanisms evolved to map specific environmental conditions onto the development of specific traits (and according to specific rules). We call these mechanisms mechanisms for adaptive plasticity (MAPs). Learning mechanisms are MAPs from environmental conditions to beliefs, or to associations, or to dispositions, etc. A belief that one can find food in a particular location is (usually) the outcome of learning mechanisms that relate (among other things) facts about where food can be found to beliefs about such facts. The mechanisms responsible for sex determination in some reptiles are MAPs from incubation temperatures to a male or female phenotype (morphology, physiology, behaviour, etc.). The mechanisms responsible for the adaptive components of the immune system are MAPs from interactions with specific pathogens to specific immune defences. The list can be extended greatly.

Some might argue that 'innate' is equivalent to 'not acquired through a MAP'. Learned traits are the developmental outcome of MAPs, and so they are not innate on this view, which is as it should be, in accordance with the minimal condition. The sex of reptiles like those mentioned above and the adaptive components of the immune system are also the developmental outcomes of MAPs, and so they are also classified as not innate. So, unlike the account which says that innateness is lack of learning, this account does not misclassify these cases. Nevertheless, 'innate' is not equivalent to 'not acquired through a MAP'. Consider, for example, the abnormally short limbs of individuals exposed to the drug thalidomide when a foetus. Such limbs are not the developmental outcome of a MAP. In spite of this, they are paradigmatic cases of non-innateness. Consider also those psychiatric conditions, such as delusions or what Damasio [16] calls *acquired sociopathy*, which are often the result of brain damage caused by illness or accident. These conditions (and the cognitive traits linked to them) are not the developmental outcomes of MAPs, and yet—as the term acquired sociopathy suggests—they are not innate. Similarly, in someone who has nine fingers because he lost one finger in an accident, the trait 'having nine fingers' is certainly not innate, but it is also not the outcome of a MAP.

3. INNATENESS AND THE GENETIC ORIGINS OF TRAITS

In one basic sense, all phenotypic traits are acquired. At conception, every animal is a single cell containing genetic and non-genetic material and does not have any differentiated traits. Differentiated traits appear later, after conception, as a result of developmental processes. Nowadays, nativists and anti-nativists agree on this: at least in this respect, we have moved past the old debate between preformationists and epigenesists [17]. Hence, an account that equates innateness with the property of being non-acquired, and which understands 'non-acquired' to mean

'present when the organism starts existing', entails that no phenotypic trait can be innate. This account clearly mischaracterizes what is at issue between nativists and anti-nativists.

An account, appealing to etymological considerations, says that innateness is the property of being non-acquired but in the sense of being already present at the moment of birth (rather than at conception) is also inadequate, as both nativists and anti-nativists nowadays agree that learned traits can develop before birth (e.g. the ability to recognize the maternal voice; [18]) and that some innate traits appear long after birth (e.g. pubic hair, sexual desires, etc.).

Some authors try to hold on to the intuition that an innate trait must in some sense be already present when the organism starts its existence by arguing that the innate traits are those that are genetically encoded. The genes of an organism are present at its conception, and so its innate traits are also present at its conception, even though only in coded form. On this view, innateness is the property of being genetically encoded. This account is accepted by many psychologists and biologists. It is also extremely popular among the general public, as shown by the fact that in the popular press innateness-talk has been replaced by gene-encoding talk. Instead of mental ability or sexual preferences being referred to as innate they are described as genetically encoded.

Nevertheless, so far no one has been able to provide an account of genetic encoding that can be used to explain what innateness is [19,20]. The code metaphor seems warranted when talking about the way DNA sequences are related to some of their immediate molecular products, such as various kinds of RNA products and polypeptide chains. But it is very difficult to justify the claim that DNA sequences code for other kinds of phenotypic traits, such as the ability to speak a language, sexual preferences, obesity, etc. (i.e. the kinds of traits that nativists and anti-nativists debate about). A genetic difference between two individuals may give rise to a behavioural difference, but that does not imply that in either individual a gene codes for that individual's distinctive behaviour [21].

Nowadays, most theorists—both nativists and anti-nativists—agree that, except for the immediate molecular products of DNA processing, all phenotypic traits are the result of causal processes that involve both genetic and non-genetic factors. This has been called the *interactionist consensus* [22]. So, if we say that a trait is genetically determined if and only if genes and nothing but genes are involved in its development, we end up with a notion of genetic determination that applies to basically no phenotypic trait other than proteins. And if we say that the development of a trait involves gene expression, we end up with a notion of genetic involvement that applies to virtually all phenotypic traits.

Nevertheless, someone who believes that the notion of genetic encoding is useful in this context will want to say that genetic encoding is different from genetic determination and from mere genetic involvement. One option is to say that a trait is genetically encoded if and only if (i) a strong statistical correlation exists between having a gene and developing that trait and (ii) this correlation is due to the way the gene affects the development of the trait (cf. [23]). As we have already noted, this relates to differences between individuals. The genetic difference between them gives rise to the phenotypic difference between them—other things being equal. This definition has the virtue of making sense of the notion of *genetic disease* and of the way this notion is usually applied, but it does not seem to be a useful way of providing a general account of innateness. This is primarily because the phenotypic differences between individuals arising from genetic differences may be mediated in the development by learning processes—thereby violating the minimal condition.

To clarify this point, suppose that in a given species of bird a strong correlation exists between having a certain gene and singing in a particular way. Suppose, moreover, that the acquisition of the song also requires learning: the development of the song requires (among other things) a sort of learning process that normally happens only in birds possessing the gene. The correlation between the gene and the distinctive song is owing to the effects that gene produces on development, including the learning processes required for the development of the song. The gene makes it possible for the bird to acquire its distinctive song. In a situation like this, according to the account considered here, the song-learning ability would satisfy the two conditions mentioned above, that is (i) and (ii), for being genetically encoded, and thereby for being innate, despite also being the result of learning.

Some scientists, such as Marler [24], might object that in the situation just described the gene codes for the special learning mechanism needed for acquiring the song, and innateness should be ascribed to the learning mechanisms and not to the song. However, it is no more satisfactory to suppose that a one-to-one relationship exists between a gene and a learning mechanism than it is to propose such a relationship between that gene and the outcome of learning. Both the mechanism and the outcome of learning satisfy the two conditions (i) and (ii). This shows that this notion of genetic encoding—at least by itself—does not help us to understand the concept of innateness.

Can a different account of genetic encoding help us in this context? According to some authors, the right account of genetic encoding is one that appeals to the theory of natural selection. Maynard Smith [25] proposes that a trait is genetically encoded if and only if the genes involved in its development (or at least some of them) were selected because they resulted in the development of that trait. In other words, a trait is genetically encoded if it is a genetically selected Darwinian adaptation. If we put this together with the thought that a trait is innate if and only if it is genetically encoded, we get the view that innateness is the property of being a genetically selected Darwinian adaptation (cf. [26]).

One problem for this view is that genetic diseases are clearly not the product of Darwinian evolution and the phenotypic effects of novel genetic mutations end up being classified as non-innate. Moreover, just like the previous one, this proposal leads to violations of the minimal condition. It is often supposed that

a genetically selected Darwinian adaptation is necessarily a trait whose development does not involve learning. But this is not true (cf. [27]). In order to illustrate this, let us go back to the birdsong example. If the ways of singing of the birds affects their fitness—e.g. through sexual selection—then there can be selection for the distinctive song mentioned above and thereby for the gene that is required (together with learning) for its acquisition. In this way, the song can become a Darwinian adaptation—a trait whose spread in the population is due to selection for it—despite the fact that the song is a learned trait. (Notice, by the way, that the relevant variation in fitness is genetically heritable, due to the role played by the gene in the acquisition of the song.)

Various kinds of foraging skills and patterns of social behaviour in mammals and birds unquestionably require learning mechanisms specifically adapted to the challenges faced by these animals, as for example in the need to recognize close kin [21,28–32]. The idea that phenotypic characters are adapted during evolution by natural selection acting on phenotypic differences owing to genetic differences is entirely compatible with the idea that the characters are learned.

4. INNATENESS AND HERITABILITY

The broad heritability of a phenotypic trait is defined as the ratio of the variance of the trait owing to genetic variation to the total variance of the trait. The variance is a statistical measure of variation, of the differences existing in a given population. If the variation in a phenotypic trait is entirely due to genetic differences, the broad heritability of the trait is 1; if it is entirely due to differences in non-genetic factors, the broad heritability is 0; if it is due partly to genetic differences and partly to non-genetic differences, the broad heritability is a number between 0 and 1.

Inferences from the high broad heritability of a trait to the innateness of that trait have often been made (cf. [33,34]). So some authors have been led to believe that, in a scientific context, innateness should be equated with high broad heritability. One well-known problem with this proposal is that, on this account, traits that are universal in a species (e.g. having one head) cannot be classified as innate: broad heritability is not defined for invariant traits. Also, on this account, traits like ‘having 10 fingers’ end-up being non-innate, given that most individuals without 10 fingers have suffered an accident, i.e. most of the variation is non-genetic (cf. [35]).

It can also be shown that a phenotypic trait can, at the same time, have high broad heritability in a population of organisms and be acquired through learning by each member of the population with that trait. Hence, this proposal violates the minimal condition. Learned traits can have high broad heritability because genetic differences can affect differences in the way that learning takes place. In the case described in the previous section, the difference between the way in which birds learn songs can be attributed to the genetic differences affecting the way they learn.

More fundamentally, the definition of heritability shows that it does not make sense to talk about the broad heritability of a trait in absolute terms. The broad heritability of a trait is always relative to a specific population of choice, and the same trait can have a different broad heritability value for different populations, in spite of its developmental features remaining constant. Hence, the account under consideration entails that the same trait can be innate according to one choice of population and non-innate according to a different choice of population. Also, it entails that two traits with exactly the same developmental features can, for certain choices of population, differ in their being innate or not being innate. In any event, the innateness of a trait should be surely determined by its developmental features alone, and it should not in any way depend on particular ways we may choose to group organisms.

5. INNATENESS AND DEVELOPMENTAL ROBUSTNESS

The invariance account of innateness states that a trait is innate if and only if it has a flat norm of reaction [36]. On this account, a trait is innate for a given genotype if and only if that trait will emerge in all of a range of developmental environments, such as, for example, the normal environments for organisms with that genotype [37]. In contrast, the canalization account of innateness says that a trait is innate if and only if it is highly canalized. Waddington [38] 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’. Environmental canalization refers to buffering or insensitivity in relation to variations in the environmental conditions met during development, while genetic canalization refers to buffering relative to variations in the genetic context. On the canalization account, a trait is innate for a given genotype if and only if the development of that trait in organisms with that genotype is highly buffered against environmental variation [39].

Both the invariance account and the canalization account try to capture and explain the intuition that, on a standard understanding, innate traits are traits whose development is difficult to avoid, at least in normal circumstances; one can think, for example, about the case of genetic diseases. Which of these accounts better captures and explains this intuition is up for debate, but we will not consider this issue here. For our purposes, it is sufficient to point out that the invariance account and the canalization account face similar problems. In particular, both accounts lead to violations of the minimal condition.

Neither a flat norm of reaction nor a high degree of environmental canalization is incompatible with learning. An animal example would be the way in which many mammals and birds recognize and respond preferentially to their close kin under natural conditions even though their highly robust adult preferences are acquired through learning early in life. Such traits are also highly canalized. The developmental processes by which these traits are acquired are insensitive to

environmental variation under most conditions in which the individuals live naturally.

Sterelny [40] has pointed out that various kinds of environmental scaffolding and processes of 'downstream niche construction' can make the development of learned traits highly canalized and as such to result in flat norms of reaction. He argues that this happens in the case of various kinds of human cognitive abilities: they are learned but also environmentally canalized and invariant. Unlike innateness, invariance and canalization are not incompatible with learning.

6. INNATENESS: CLUTTER OR CLUSTER?

Consider again the concept of jade, i.e. the concept expressed by the mineralogical term 'jade'. This concept was once thought to refer to a single 'substance', to a natural kind (like gold), to something whose essence is determined by a single theoretically useful property: the property of having a certain kind of (to be discovered) microstructure. But then the experts found out that the samples of matter that people were classifying as jade did not all have the same chemical microstructure. Some samples were discovered to be a combination of sodium and aluminium; this compound is now known as jadeite. Other samples were discovered to be a combination of calcium, magnesium and iron; this compound is now known as nephrite (cf. [41]). It was the French mineralogist Alexis Damour who, in the nineteenth century, made these discoveries. If, in the light of Damour's discoveries, we wanted to keep the concept of jade as a natural kind concept, we could say that 'jade' refers to jadeite only. If we chose this option, many (but not all) of the classifications and inferences that people make when they talk about jade would turn out to be correct. Or we could say that 'jade' refers to nephrite only. If we chose this option, many (but not all) of the classifications and inferences that people make when they talk about jade would turn out to be correct. But different classifications and inferences would come out as correct according to which of these two options is taken: identifying jade with jadeite requires that we see as false and mistaken all the claims and inferences that people make when they use the term 'jade' to talk about nephrite, and vice versa. Because of this, the reasonable thing to say is that jade conflates two theoretically (in this case, chemically) interesting properties that we have discovered to be distinct.

Until recently relatively little evidence indicated that the concept of innateness was not coherent or theoretically useful. But it looks as if we are now in a position to recognize that 'innateness' has been used to refer to many distinct non-overlapping properties. Some of these properties are such that keeping track of them is extremely useful in the study of biological and psychological traits. But the use of 'innateness' may lead scientists to infer incorrectly that the presence of one of these properties in a trait implies the presence of the other properties as well. The list of such properties is long. It includes those mentioned in the accounts examined in the previous sections: the property of being not learned, the property of not being the outcome of a mechanism for adaptive plasticity, the property of being genetically encoded in the sense of being highly correlated with specific genes owing to the influence of such genes on development, the property of being genetically encoded in the sense of being a genetically selected Darwinian adaptation, the property of having high broad heritability, the property of having a flat norm of reaction, and the property of being highly environmentally canalized. But the list also includes other properties, such as: the property of being universal within a species (or within a biologically significant segment of a species), the property of being developmentally modular, the property of reliably developing during a specific stage of the life cycle, the property of being the developmental outcome of a functionally specialized acquisition device, etc.

Just as in the case of jade, if we identify innateness with any of these properties—that is, if we adopt a theory that equates innateness with a single one of these properties—some of the inferences and classifications that scientists routinely make when they use the concept of innateness will come out as warranted, while others will not. Different inferences and classifications will come out as warranted for different choices of property. Because of this, the most reasonable thing to say seems to be that the concept of innateness, just like the concept of jade, conflates theoretically useful properties that scientists have found to be distinct. This is the clutter hypothesis [8].

Some will want to argue that the available evidence in support of the clutter hypothesis is not decisive. Perhaps, a satisfactory account of the concept of innateness, one that shows that the notion is coherent and theoretically useful, is still possible. One alternative to the clutter hypothesis is what we are going to call the *cluster hypothesis*. According to this hypothesis, innateness is what has been called in the philosophical literature 'a homeostatic property cluster' [42], a set of properties that tend to co-occur as a result of underlying causal processes that connect these properties in reliable ways. No property in the cluster needs to be present in all instances of the category, but the causally sustained correlation between the properties is such that one can often—with a relatively high degree of confidence—infer the presence of one property from the presence of other properties in the cluster. (One can of course have homeostatic property clusters in which some of the properties in the cluster are present in all instances of the category. That would be just a special case.) Boyd [42] has argued that various scientific concepts refer to clusters like these. He has argued, for example, that the concepts of biological species refer to homeostatic property clusters, i.e. that the concept of 'lion' or 'dog' refer to homeostatic clusters of (morphological, physiological and psychological) properties of organisms. Perhaps, the concept of innateness refers to a homeostatic property cluster too. In this case, the properties would be properties of psychological and biological traits rather than properties of organisms.

Consider inferences from 'a given trait is innate' to 'that trait has a given property' and inferences from 'the trait has a given property' to 'that trait is innate'.

Let us call *i-properties* all the properties of traits that regularly figure in inferences of this form, especially when the inferences are made by scientists. The cluster hypothesis says that the i-properties (or at least a significant number of them) form a homeostatic property cluster. It also says that one can give a satisfactory account of innateness by equating innateness with that cluster. According to this view, the existence of such a cluster both explains and vindicates (most of) the inferences that nativists and anti-nativists make when they debate with each other. Nativists and anti-nativists infer the presence (or absence) of innateness in a particular trait from the presence (or absence) of various i-properties in the same trait, and vice versa. This also means that nativists and anti-nativists often use the concept of innateness to infer the presence (or absence) of some i-properties in a trait from the presence (or absence) of other i-properties in that trait. An example of this would be the inference from 'the trait has high broad heritability in the population' to 'the trait is highly canalized in individual members of the population' (cf. [34]).

According to the cluster hypothesis, these inferences are not 100 per cent reliable because—given the way homeostatic property clusters work—a trait can have many i-properties and still lack some other i-properties. But, as the i-properties tend to co-occur, many of these inferences will have a high level of reliability. Thus, on this view, by using the concept of innateness, nativists and anti-nativists track (or refer to) something real, a sort of 'syndrome' which some traits (the innate ones) have and other traits (the non-innate ones) do not have. The disagreements between nativists and anti-nativists are disagreements about which traits have this syndrome and which traits do not have it. They are about which traits are members of the category defined by the homeostatic property cluster and which traits are not members of this category. The other hypothesis, the clutter hypothesis, in contrast, says that this syndrome does not exist, and that the syndrome (the cluster) is an illusion.

Which of the two hypotheses about the concept of innateness is correct? If the arguments we have given so far are correct, the answer to this question depends on the existence and nature of the homeostatic property cluster. Someone who argues that the cluster hypothesis is correct has to give an account of the i-properties that constitute the cluster, of the causal processes that connect such properties and cause them to tend to co-occur. In other words good evidence must be provided for the claim that a cluster actually exists and is not an illusion. If this cannot be done then the clutter hypothesis is supported. Our current opinion is that no clear and well-defined cluster exists, at least not for the case of human cognitive traits. We also recognize that this is still an empirical matter and therefore an open issue.

In any case, the investigation of the way the various i-properties relate to each other is something that should be encouraged. Apart from telling us whether a way can be found of making the concept of innateness scientifically respectable, this investigation will be extremely useful for biological and scientific theorizing. An understanding, for example, of the relation between a history of Darwinian evolution and the presence (or absence) or canalization, or the presence (or absence) of learning in the developmental process is something worth pursuing independently of any concerns one might have about the scientific respectability of the concept of innateness. Whether the presence (or absence) of learning may (or may not) result in a canalized developmental process is an interesting matter. So, in the end, even those who are not particularly interested in evaluating the concept of innateness may find that interesting empirical questions and new ways of seeing old issues may be generated by an examination of this concept.

7. WHY LETTING GO OF INNATENESS IS HARD

Here is a possible objection to the clutter hypothesis. Some nativist debates (i.e. debates about whether a particular trait is or is not innate) are very old. If the concept of innateness conflated different theoretically interesting properties, people would have certainly noticed a long time ago. But they did not. So, it might be argued, innateness does not conflate distinct properties. This is an important challenge to the clutter hypothesis. One way to reply is to say that it is only in the light of our current best theories that the evidence in favour of the clutter hypothesis has been forthcoming. This is why the analogy with jade is useful. Just like in the case of jade, the epistemic situation in the past was different. Damour discovered that people were using the concept of jade to keep track of two chemical microstructural properties that—he argued convincingly—need to be kept distinct in good chemical theorizing. In the same way, only recently have people started realizing that many properties that were previously tracked using the notion of innateness need to be kept distinct in good biological and psychological theorizing.

It could be argued that some evidence in support of the clutter hypothesis has been around for a considerable time. For example, in a footnote in section II of the *Enquiry Concerning Human Understanding* (1777), Hume complained that the notion of innateness was ill-defined and that those who used it were in danger of drawing out 'their disputes to a tedious length, without ever touching the point in question'. One possibility is that Hume did not really have much evidence for this claim, and that his complaint was only a rhetorical trick in support of his anti-nativist views. But, given what he actually wrote, this seems to be too uncharitable an interpretation. Some evidence in support of the clutter hypothesis has been around for a long time and some of this evidence was available to Hume. If so, why has the clutter hypothesis not been taken seriously by so many of the participants in the various nativist debates?

One possible explanation is that the concept of innateness is deeply entrenched in scientific theorizing because it is similarly entrenched in everyday thinking. Recent data collected by cognitive anthropologists suggest that this notion is pancultural and that the distinction between innate and non-innate traits 'comes naturally' to human beings (cf. [43]). Its development

(or, to be more precise, the development of the cognitive mechanisms underpinning its use in thought) seems to be canalized and buffered against various kinds of changes in developmental environments. If correct, this can explain why it is difficult to let go of the concept of innateness, both in folk thinking and in scientific theorizing. (Some of the cognitive anthropologists and developmental psychologists who have studied the development and cultural distribution of the psychological distinction between innate and non-innate traits suggest that this distinction is itself innate. But, if the clutter hypothesis is correct, better ways of expressing this thought can be identified, ways that do not make any use of the concept of innateness.)

Another possible explanation of why, until recently, only a few theorists have entertained and been worried by the possibility that the clutter hypothesis might be true concerns the fact that the nativist debates (at least some of them) are often debates about important matters. For example, the studies about the broad heritability of IQ generated all the controversy that they did partly because some authors wanted to argue that the high heritability of IQ indicated that it was pointless to invest money in improving education [33,34]. Many have pointed out that the inference from 'IQ is highly heritable' to 'environmental intervention will have little impact on IQ' was flawed [35]. But the debate was an important one. Should we spend a lot of money on education? Or would such investments be a waste of resources? These, surely, are important questions.

The problems that the nativist debates like this one try to address do not disappear when it has been shown that the concept of innateness does not manage to track any single property. It may be argued that the clutter hypothesis is commonly perceived as a threat to these important debates, and it is perhaps because of this that many authors have ignored the possibility that the hypothesis might be true. But this common perception is mistaken. Even if it turns out that the concept of innateness is not theoretically useful, it does not follow that all nativist debates are misguided or pointless. It follows instead that the ways of conducting at least some of these debates can be improved.

If the problems raised by the debates are important, then we should make sure that the conceptual tools that we use are sound. Only in this way will we avoid conceptual traps and bad inferences. Only in this way have we some chance of getting the right answers. One can argue, for example, that in the case of the debates about the heritability of IQ, the mistaken inference from 'high heritability' to 'difficult to modify through education' was made via the use of the concept of innateness. The inference was from 'IQ has high broad heritability' to 'IQ is innate' to 'IQ is highly environmentally canalized' to 'we cannot affect IQ through education'. Mistaken inferences of this kind are common. Is not this a good reason for thinking that the concept of innateness conflates properties that should be kept distinct?

Some nativist debates are about whether the development of a particular trait involves learning or some other mechanism for adaptive plasticity. Others are about whether a trait can be modified by learning or by some other kind of environmental intervention, independently of the way it developed. Some nativist debates are really about whether a particular trait is environmentally canalized with respect to a specific range of variation; they are about whether we can affect the development of a trait via interventions that are available to us. Some debates are about the evolutionary origins of phenotypes, while others are about the broad heritability of a specific trait in a specific population. And so on. Given our best theories about the development and evolution of psychological and biological traits, no good reason exists to think that all these debates have something in common. But this should not worry those who believe that any one of these debates are important. The important debates are not threatened by the clutter hypothesis. If the clutter hypothesis is correct, better ways of conducting at least some of those debates can be found, ways that do not make any use of the concept of innateness. Identifying these alternative, more focused ways of conducting the debates about the developmental and evolutionary origins of traits will certainly generate progress in the biological and cognitive sciences, and it will help scientists resolve their differences.

Understanding human diversity provides the central theme of this volume. Resolving the confusions that have swirled around the debate about innateness is an important step in achieving such understanding. Also important is the need to distinguish between population arguments about sources of variation and mechanistic issues dealing with how an individual develops. Genetic differences may well be correlated with some phenotypic differences between humans, but such knowledge is quite separate from the knowledge of developmental process. Furthermore, regularities in development do not necessarily imply regularities in the phenotype. The rules of a game like chess are straightforwardly simple, but the range of possible games between two players is enormous. As these issues clarify, we share the hope of the editors that many scientists who thought they disagreed with each other will find that they do not.

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REFERENCES

1 Chomsky, N. 1986 *Knowledge of language*. New York, NY: Praeger.
2 Pinker, S. 1998 *How the mind works*. New York, NY: Norton.
3 Bateson, P. 1991 Are there principles of behavioural development? In *The development and integration of behaviour* (ed. P. Bateson). Cambridge, UK: Cambridge University Press.
4 Bateson, P. & Mameli, M. 2007 The innate and the acquired: useful clusters or a residual distinction from folk biology? *Dev. Psychobiol.* **49**, 818–831. (doi:10.1002/dev.20277)
5 Griffiths, P. E. 2002 What is innateness? *Monist* **85**, 70–85.
6 Griffiths, P. E. & Gray, R. D. 1994 Developmental systems and evolutionary explanation. *J. Phil.* **XCI**, 277–304. (doi:10.2307/2940982)

7 Griffiths, P., Machery, E. & Linquist, S. 2009 The vernacular concept of innateness. *Mind Lang.* **24**, 605–630. (doi:10.1111/j.1468-0017.2009.01376.x)
8 Mameli, M. 2008 On innateness: the clutter hypothesis. *J. Phil.* **CV**, 719–737.
9 Mameli, M. & Bateson, P. 2006 Innateness and the sciences. *Biol. Phil.* **21**, 155–188. (doi:10.1007/s10539-005-5144-0)
10 Samuels, R. 2002 Nativism in cognitive science. *Mind Lang.* **17**, 233–265. (doi:10.1111/1468-0017.00197)
11 Cowie, F. 1999 *What's within: nativism reconsidered*. Oxford, UK: Oxford University Press.
12 Tomasello, M. 2003 *Constructing a language*. Cambridge, MA: Harvard University Press.
13 Yntema, C. L. & Mrosovsky, N. 1982 Critical periods and pivotal temperatures for sexual differentiation in loggerhead sea turtles. *Can. J. Zool.* **60**, 1012–1016. (doi:10.1139/z82-141)
14 Sompayrac, L. M. 2008 *How the immune system works*, 3rd edn. Oxford, UK: Blackwell.
15 Alberts, B., Alexander, J., Lewis, J., Raff, M., Roberts, K. & Walter, P. 2002 *Molecular biology of the cell*, 4th edn. New York, NY: Garland.
16 Damasio, A. 1994 *Descartes' error: emotion, reason, and the human brain*. New York, NY: Putnam.
17 Pinto-Correia, C. 1997 *The ovary of Eve*. Chicago, IL: University of Chicago Press.
18 Spence, M. J. & DeCasper, A. J. 1987 Prenatal experience with low-frequency maternal voice sounds influences neonatal perception of maternal voice samples. *Infant Behav. Dev.* **10**, 133–142. (doi:10.1016/0163-6383(87)90028-2)
19 Godfrey-Smith, P. 2007 Innateness and genetic information. In *The innate mind*, vol. 3 (eds P. Carruthers, S. Lawrence & S. Stich). New York, NY: Oxford University Press.
20 Griffiths, P. 2001 Genetic information: a metaphor in search of a theory. *Phil. Sci.* **68**, 394–412. (doi:10.1086/392891)
21 Bateson, P. & Martin, P. 1999 *Design for a life*. London, UK: Cape.
22 Sterelny, K. & Griffiths, P. 1999 *Sex and death*. Chicago, IL: University of Chicago Press.
23 Dawkins, R. 1982 *The extended phenotype*. Oxford, UK: Oxford University Press.
24 Marler, P. 2004 Innateness and the instinct to learn. *An. Acad. Bras. Cienc.* **76**, 189–200. (doi:10.1590/S0001-37652004000200002)
25 Maynard Smith, J. 2000 The concept of information in biology. *Phil. Sci.* **62**, 177–194. (doi:10.1086/392768)
26 Symons, D. 1992 On the use and misuse of Darwinism in the study of human behavior. In *The adapted mind* (eds J. H. Barkow, L. Cosmides & J. Tooby). Oxford, UK: Oxford University Press.
27 Lehrman, D. S. 1970 Semantic and conceptual issues in the nature-nurture problem. In *Development and evolution of behavior* (eds L. Aronson, E. Tobech, D. S. Lehiman & J. Rosenblatt). San Francisco, CA: Freeman.
28 Gerlach, G., Hodgins-Davis, A., Avolio, C. & Schunter, C. 2008 Kin recognition in zebrafish: a 24-hour window for olfactory imprinting. *Proc. R. Soc. B* **275**, 2165–2170. (doi:10.1098/rspb.2008.0647)
29 Hepper, P. G. 1991 *Kin recognition*. Cambridge, UK: Cambridge University Press.
30 Lihoreau, M. & Rivault, C. 2009 Kin recognition via cuticular hydrocarbons shapes cockroach social life. *Behav. Ecol.* **20**, 46–53. (doi:10.1093/beheco/arn113)
31 Shettleworth, S. J. 1998 *Cognition, evolution and behavior*. New York, NY: Oxford University Press.
32 Lieberman, D., Tooby, J. & Cosmides, L. 2007 The architecture of human kin detection. *Nature* **445**, 727–731. (doi:10.1038/nature05510)
33 Herrnstein, R. J. & Murray, C. 1994 *The bell curve*. New York, NY: Free Press.
34 Jensen, A. R. 1969 How much can we boost I.Q. and scholastic achievement? *Harv. Educ. Rev.* **33**, 1–123.
35 Block, N. 1995 How heritability misleads about race. *Cognition* **56**, 99–128. (doi:10.1016/0010-0277(95)00678-R)
36 Schmalhausen, I. I. 1949 *Factors of evolution*. Philadelphia, PA: Blakiston.
37 Sober, E. 1998 Innate knowledge. In *Routledge encyclopedia of philosophy* (ed. E. Craig). London, UK: Routledge.
38 Waddington, C. H. 1975 *The evolution of an evolutionist*. Ithaca, NY: Cornell University Press.
39 Ariew, A. 1999 Innateness is canalization: a defense of a developmental account of innateness. In *When biology meets psychology* (ed. V. Hardcastle). Cambridge, UK: MIT Press.
40 Sterelny, K. 2003 *Thought in a hostile world*. London, UK: Blackwells.
41 Putnam, H. 1975 The meaning of 'meaning'. In *Language and reality: philosophical papers*, vol. 2 (eds Putnam & H. Mind). Cambridge, UK: Cambridge University Press.
42 Boyd, R. 1991 Realism, antifoundationalism, and the enthusiasm for natural kinds. *Phil. Stud.* **61**, 127–148. (doi:10.1007/BF00385837)
43 Astuti, R., Solomon, G. A. & Carey, S. 2004 Constraints on conceptual development: a case study of the acquisition of folkbiological and folksociological knowledge in Madagascar. *Monogr. Soc. Res. Child Dev.* **69**, 1–135. (doi:10.1111/j.0037-976X.2004.00297.x)