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Nature and Nurture in Cognition

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ABSTRACT

This paper advocates a dispositional account of innate cognitive capacities, which has an illustrious history from Plato to Chomsky. The 'triggering model' of innateness, first made explicit by Stich ([1975]), explicates the notion in terms of the relative informational content of the stimulus (input) and the competence (output). The advantage of this model of innateness is that it does not make a problematic reference to normal conditions and avoids relativizing innate traits to specific populations, as biological models of innateness are forced to do. Relativization can be avoided in the case of cognitive capacities precisely because informational content is involved. Even though one cannot measure output relative to input in a precise way, there are indirect and approximate ways of assessing the degree of innateness of a specific cognitive capacity.

1 Introduction

The basic issue concerning the innateness of our cognitive endowment can be stated rather simply: Are some of our ideas, concepts, beliefs, capacities, and other mental items innate?[1] Nativists argue that a substantial part of our cognitive endowment is innate, while anti-nativists think that the innate component is only a small and insubstantial part. But upon closer inspection, a variety of complications intrude. For example, few nativists if any would claim

[1] In what follows, I will be concerned with contentful cognitive states in general, but I will be steering clear of innate *knowledge*. Psychologists often speak of knowledge here, though not in the way in which philosophers do; for them, 'knowledge' is roughly interchangeable with 'belief'. Avoiding talk of knowledge in this context enables us to bracket some of the questions traditionally associated with the debate between rationalism and empiricism, namely, whether there is a priori knowledge, knowledge justified without recourse to experience. The latter issue pertains to the manner of *justification* rather than the manner of *acquisition* of mental states, which is to be the main focus here.

that all innate ideas should be fully available at birth and that they spring forth full-grown and armored, like Athena from the forehead of Zeus. Instead, nativists typically say that (1) innate ideas need *not manifest* themselves at birth. Moreover, innate ideas generally do not become ready for use without any prompting, so nativists hold that (2) some environmental *stimulus* is needed for these ideas to become available. In addition, even when they do become available, many nativists claim that (3) some innate ideas may remain *tacit* or unconscious rather than explicit or fully accessible to consciousness. Thus, nativists allow that innate ideas need not be conscious even when manifest.

These are some of the complexities involved in formulating the doctrine of innate ideas in a philosophically respectable way. Other difficulties are of more recent provenance, and have come to the fore particularly in the biological and cognitive sciences. It has become apparent that one cannot simply identify what is innate with what has been contributed by the cognizer, and what is not innate with what has been supplied by the environment, for these are not separable components of developmental history. Thus, nativists acknowledge that (4) there are complex *interactions* between nature and nurture, or genes and environment, and the contribution of each to the resultant competence cannot simply be prized apart. Moreover, one cannot eliminate one to investigate the effect of the other, since each on its own gives rise to nothing at all (see Section 5 for more on this issue). Added to this is an increasing realization among nativists that (5) the old dichotomy between innate and acquired capacities cannot be maintained in the face of evidence that innateness is a matter of *degree*. If the concept of innateness is to retain any use, the dichotomy must be replaced with a spectrum.

Because of these complications, as well as for other reasons, numerous authors have called on investigators to drop the distinction between innate cognitive capacities and acquired or learned ones. Yet the concept of innateness refuses to die, and it continues to be useful in diverse cognitive domains, ranging from the development of birdsong to the acquisition of human language. The challenge is therefore to articulate the concept of innateness as applied to mental states in such a way that it can stand up to philosophical scrutiny. In this paper, I will make an attempt to do so, bearing in mind the five complications enumerated in the previous two paragraphs.

2 Two models of innateness

As I stated in the Introduction, few nativists hold that infants emerge from the womb with full-blown beliefs (or even ideas) ready to be manifested without further encouragement. That seems highly unlikely. Rather, the doctrine of innateness must be about a certain disposition or propensity to manifest certain beliefs rather than others at a relatively early age with little prompting. But this also raises problems, since the nature of the prompting is crucial: if it is too explicit and full-bodied, why not talk about teaching instead? In order to get some purchase on the whole controversy, Stephen Stich ([1975]) has proposed two strategies or models for making sense of the doctrine of innate mental items. The first he traces back to Descartes, and the second to Plato (though these can be thought of as convenient tags rather than genuine attributions):

Cartesian model: innate beliefs are like innate *diseases*.

Platonic model: innate beliefs are *triggered* by certain processes, but are not found in them.

In the following section, I will argue that the first model should be eliminated in favor of the second. In order to make this case, I will first need to sketch these accounts out in more detail.

In describing the Cartesian model, Stich begins by noting that to have a disease innately is not necessarily to have the symptoms from birth. A person may have an innate disease though none of its symptoms are present from birth; the symptoms may appear at a later stage in life. As in the case of belief, there is nothing unusual about the claim that a person had the disease all along, though the symptoms appeared later on (Stich [1975], pp. 3–4). Moreover, since some innate diseases are thwarted or cured, one needs to allow that they can be present without *ever* becoming manifest. Stich tries to get around this problem with a reference to 'normal' conditions: innate diseases are ones that would manifest themselves in the *normal* course of events. This introduces a certain amount of vagueness into the notion of an innate disease, because of the vagueness of the notion of 'normalcy'. But he claims that this is not a defect of the analysis, since vagueness is already built into the notion of an innate disease: it is sometimes indeterminate whether a person is afflicted with an innate disease, or is susceptible to a non-innate disease (*Ibid*., pp. 6–7). In general, the more common the conditions that trigger the disease, the more we are likely to say that it is genuinely innate, since under normal circumstances the person will develop it no matter what. But if the conditions triggering it are unusual, occurring only in the Himalayas, say, so that most people who have the condition will not develop the disease, we are more likely to say that the person has a susceptibility to a non-innate disease (*Ibid*., p. 7). When applied to the case of innate beliefs, the following dispositional analysis emerges:

> A person has a belief innately at time t if and only if from the beginning of his life to t it has been true of him that if he is or were of the appropriate age then he has, or in the normal course of events would have, the belief occurrently or dispositionally. (*Ibid*., p. 8)

One advantage of this analysis is that it preserves the intuition with which we started, namely that one can have a belief innately without actually believing it at birth. In fact, Stich says that one need not believe it 'dispositionally' or 'occurrently' at birth (*Ibid.*, p. 9). In other words, an innate belief is one that we need not have at birth, whether tacitly or explicitly (compare points (1) and (3) in Section 1).

So much for the virtue of this account. The problem with it is that it seems to count too many beliefs as innate, because there are a great many beliefs that we would certainly acquire in the normal course of events. As Stich points out, we normally acquire such beliefs as: day follows night, things fall when dropped, water quenches thirst, and so on. We definitely should not count *all* these beliefs as innate (*Ibid.*, p. 9). However, if we relax matters, so that normalcy is very austere, then perhaps *no* belief will turn out to be innate. But surely our account should leave this open to empirical investigation. Therefore, Stich proposes a variation on this account: a belief is innate for a person if he or she is disposed to acquire it under circumstances sufficient for the acquisition of any belief whatsoever (*Ibid.*, p. 12). However, it is not immediately clear what Stich means by circumstances sufficient for the acquisition of any belief whatsoever. If these are understood as circumstances sufficient for the acquisition of *every belief*, then the condition becomes a trivial one and the resultant account highly implausible. All beliefs would be acquired under such circumstances, but we would surely not want to classify them all as innate. If, on the other hand, they are understood in terms of circumstances sufficient for the acquisition of *at least one belief*, then there may be no other beliefs (or at any rate, very few) that are acquired under circumstances sufficient for the acquisition of a single belief.[2] The conditions sufficient for the acquisition of a fairly straightforward belief, for example the belief that there is food in front of me, might be very minimal. But such conditions are likely not to be sufficient for the acquisition of innate beliefs that require specific triggers to be acquired. It can therefore be safely concluded that Stich's condition would either rule in a range of obviously non-innate beliefs, or rule out a whole range of putative innate beliefs.

After explicating the disease model of innateness, Stich goes on to discuss a model of innateness inspired by Plato's *Meno*. On his interpretation, the slave boy's beliefs in this Platonic dialogue arise as a result of questioning and there is no suggestion that the belief would have arisen without the questioning (*Ibid.*, pp. 13–4). Stich's gloss on this process is the metaphor of a trigger or

[2] There may be a third possibility: circumstances sufficient for the acquisition of *some specified belief*. If so, we need to know what that belief would be. There may be a belief such that the circumstances sufficient for its acquisition are sufficient for the acquisition of all the beliefs we wish to consider as innate. But if there is, there does not seem to be an obvious way of discovering it.

catalyst. Since a trigger or catalyst facilitates the production of the end product and does not actually provide its entire content, this shows how triggering is different from teaching, which actually supplies the content of the resulting belief. To further support this account of innateness, he refers to the Leibnizian metaphor of a piece of marble that already has certain veins from which the workman or sculptor can profit (*Ibid.*, p. 14). According to Stich, yet another variant on the triggering metaphor comes from Chomsky, who suggests looking at belief acquisition as an input–output process, with sensory experience as input and cognitive competence as output. As Chomsky puts it ([2000], p. 4), the initial state of the language acquisition device 'takes experience as "input" and gives the language as an "output"—an "output" that is internally represented in the mind/brain'. On Chomsky's view, if the output that results from experience contains more information than the experience itself, then this addition must be the mind's innate contribution. It may be added that this account of innateness fits nicely with what might be called the ur-argument for innateness: the argument from the 'poverty of the stimulus'. This argument states that, for a given mental state X and environment Y, if Y is too impoverished to have caused X on its own, then there must have been some innate contribution in the acquisition of X.

But this Platonically-inspired account of innateness is inadequate as it stands: more needs to be said concerning the manner of measuring the comparative information content of experiences and beliefs. In particular, as Stich observes, many empirical beliefs will be richer in information content than the experience that led to their acquisition, since evidence rarely entails the belief—paradigmatically, in inductive generalizations ([1975], p. 15). Still, he concludes that despite the shortcomings of this account, the upshot of it is that the interesting question becomes: to what *degree* are our various beliefs innate? (*Ibid.*, p. 16).

3 Discarding the disease model

In this section, I will argue that the first model of innateness should be rejected in favor of the second. The first says (roughly) that a belief is innate if it would be acquired in the *normal* course of events. The second model says that a belief is innate if it would be *triggered* rather than taught, where a trigger has much less informational content than the belief itself. Both accounts serve to remind us that innateness is a matter of degree. The first model says that the more normal the circumstances, the more innate the acquired belief, and the second says that the weaker the trigger or stimulus, the more innate the resultant belief.

But it would be too hasty to conclude that there are two distinct degrees of freedom here. To see this, begin by incorporating the trigger into the circumstances surrounding belief acquisition. Since the triggering conditions can be thought of as one aspect of the surrounding circumstances, these two elements need not be conceived to be entirely distinct. They may draw attention to different aspects of the ambient environment of the cognizer but they should not be considered completely separate factors. Indeed, I will argue for a stronger conclusion: it is not the normalcy of the conditions that is at issue, but rather the fact that these conditions are sufficient to *trigger* a certain belief but insufficient to *teach* that same belief. Thus, the first model should be rejected in favor of the second.

Consider two cases: the acquisition of beliefs in the domain of language, and the domain of calculus. When it comes to language, circumstances in which children are brought up with mere exposure to a natural language and without much formal instruction are thought to be in a 'normal' environment. Since linguistic beliefs are acquired in these 'normal' circumstances, language is argued to be (partly) innate. By contrast, when it comes to beliefs about calculus, circumstances in the mathematics classroom in which these beliefs are taught are 'abnormal', or at any rate exceptional or remarkable. At least this is what we must suppose for the account to work. In the first case, beliefs are acquired even though the circumstances are normal, whereas in the second case beliefs are only acquired in abnormal circumstances. Therefore, in the first case, we are able to conclude that there must be a substantial innate endowment, while in the second case, there is no such innate endowment.

These considerations bring out the oddity of using the notion of 'normalcy' in this context. The basic idea is that the conditions need to be unremarkable in the sense that there is nothing in them that would lead us to expect that the resulting beliefs would be acquired without some significant help, specifically from the innate cognitive endowment of the organism. Invoking normalcy is positively misleading, since in some cases it is the very abnormality of the conditions of acquisition that points to the innateness of capacities acquired. For example, some animals acquire cognitive spatial abilities without the benefit of being raised in a lighted environment. This has been taken as good evidence that the spatial abilities involved are largely innate. Likewise, some species of birds develop adult song even when reared in isolation from conspecifics, which is also taken as evidence that birdsong in these species is innate.[3] But these circumstances are *prima facie* highly *ab*normal, relative to the typical developmental history of members of those species: they are so

[3] Spelke reports that depth perception appears to develop without visual experience in many species: 'cliff avoidance in rats was shown to be independent of experience: dark-reared rats, tested on first exposure to light at 3 months, consistently avoided the visual cliff' ([1990], p. 107). Johnston ([1988]) critically surveys much of the literature on birdsong. Among the many results he reports is the finding that there is no difference between the songs of flycatchers reared in the wild and those reared in isolation ([1988], p. 620).

impoverished as to be abnormal, rather than so *rich* as to be abnormal (as in the mathematics classroom). Therefore, the operative factor is the degree of impoverishment of the circumstances relative to the beliefs acquired, which is indeed what enables us to classify them as *triggering* circumstances.

Collapsing the two models of innateness into a single model by incorporating the trigger into the circumstances and dispensing with the notion of normalcy has the further advantage of reducing the two problems with which we began to a single problem. Recall that the problem with the first account was the difficulty of spelling out normalcy, since it did not seem enough to say that normal conditions were ones sufficient for the acquisition of any belief whatsoever. That was because conditions sufficient for the acquisition of at least one belief may not be sufficient for the acquisition of any other beliefs, thus ruling out the possibility of innate beliefs by fiat. Meanwhile, the problem with the second account was that there does not seem to be a ready way of measuring informational content. Moreover, many beliefs seem richer in informational content than the evidence on which they are based, yet it seems unlikely that all such beliefs are innate. This applies to paradigmatically non-innate beliefs, for example, those empirical generalizations that are informationally richer than the stimuli upon which they are inductively based. We are therefore left with a single problem surrounding innateness: How do we measure the strength of the stimulus relative to the strength of the acquired belief in such a way as to enable us to assess the degree of innateness of that belief? Integrating the two models into a single account has not enabled us to resolve this question, but it has further clarified the nature of the question.

Here, the objection may be raised that we must not drop normalcy from our account, since we cannot do without a reference to normal conditions in our analysis of the nature of an innate belief or idea. After all, if conditions are highly abnormal in certain ways, then one can no longer expect that innate cognitive capacities will be manifested. To take an extreme example, if the cognizer is severely undernourished then it may become barely functional and fail to acquire any cognitive capacities at all, let alone innate ones.[4] Now, it is certainly true that dispositional analyses generally make a crucial reference to normal conditions (for example, in the case of chemical reactions, standard temperature and pressure). But, in the case of cognitive development, if normalcy amounts merely to the conditions necessary for the proper functioning of the organism, then these conditions are too minimal to provide us with an account of an innate mental state. Furthermore, as we saw above, Stich's proposal that normal conditions are those sufficient for the

[4] This point is made by a number of authors; see, for example, Gifford ([1990], pp. 329–30), and Ariew ([1999], pp. 130–1).

acquisition of any belief whatsoever is not an adequate analysis of an innate belief, precisely because there may be many innate beliefs that would not be manifested in such 'normal' conditions—namely those that require certain specific triggers to be manifested. Worse, it appears as though some paradigmatically-innate capacities are manifest in what we would naturally consider highly abnormal conditions; in these cases, the very abnormality of the conditions is an indicator of the innateness of the capacities. In order to capture what is distinctive about innateness, I have argued that one must say something about the informational content of the output relative to the input. As with other dispositional accounts, the account is framed against the background of normal conditions, in the sense of conditions that must be in place for the proper functioning of the cognizer. In their absence, cognitive capacities will not be allowed to manifest themselves at all, no matter whether they are innate or not. Thus, normalcy should serve merely as a background to the account, and should be understood in terms of the minimal conditions necessary for the proper functioning of the organism.

4 Impoverishment and implasticity

In order to defend the triggering model of innateness, I need to say more about the problem of measuring the informational content of the stimulus relative to the resulting competence, in such a way as to assess the degree of innateness. To clarify this problem, I will sketch out a rival to the model of innateness I have been explicating: the canalization (or implasticity) account. Drawing on work in developmental biology, André Ariew ([1999]) has argued that the degree to which a certain developmental process is canalized is the degree to which the process is bound to produce a particular end-state despite environmental fluctuations, both in the initial state and during the course of development. Then, a trait produced by such a process is said to be innate to the extent or degree to which its developmental outcome is canalized. Ariew ([1999], p. 128) observes that in highly canalized (or implastic) developmental processes there often exists a high degree of constancy (or robustness) of phenotypes over a fairly well-defined 'normal' range of environmental conditions.

This account has affinities to a recent explication of the notion of innateness due to Elliott Sober ([1998]). In order to articulate a notion of innate knowledge, Sober utilizes a number of insights derived from biological work on innateness. After making the point that the difference between innate and acquired traits is not a dichotomy but a matter of degree, he attempts to articulate a notion of innateness that can serve for biology as well as have relevance to contemporary philosophy. He advances the hypothesis that 'the most that can be salvaged from the ancient concept of innateness is this: *a phenotypic trait is innate for a given genotype if and only if that phenotype will emerge in all of a range of developmental environments*' (Sober [1998], p. 795; original emphasis). Sober adds that it is difficult to evade the conclusion that what counts as the appropriate range of environments will be determined pragmatically.

Despite the obvious similarity between Sober's account and Ariew's, the latter claims that the canalization account is superior to both Sober's account and to Stich's disease model of innateness discussed (and rejected) above. He holds that both fail to distinguish two ways in which a developmental process or the resultant trait can demonstrate invariance (Ariew [1999], p. 134):

1. By means of strict genetic control, so that the outcome is insensitive to the environmental conditions.
2. By means of a developmental sensitivity only to environmental factors that are themselves invariant within the organism's (normal) developmental environment.

In light of this distinction (borrowed from T. D. Johnston), only the first case is a genuine instance of canalization. Intuitively, in the second case there is no real implasticity or canalization. It is rather that the organism is 'fortunate' in not *normally* encountering or being sensitive to any environmental stimuli that lead to large variations in its end-state.

Ariew's point is well taken, but it simply further underlines the pitfalls of citing 'normal' conditions in order to characterize the distinctive features of innateness.[5] Depending on how normal conditions are picked out, we may find that some relevant environmental factors were not varied, so that the resultant implasticity is a mere artifact of our choice of environments. However, Ariew himself falls into the normalcy trap when he refers in his definition to 'a fairly well defined "normal" range of environmental conditions' ([1999], p. 128). He does so despite the fact that he clearly acknowledges that some innate traits develop in impoverished and abnormal conditions. In fact, he goes on to admit that there is a problem in deciding which range of conditions or environments are relevant to deciding the degree of innateness in any given case, and ends by saying that it is relative to the case involved. However, since our judgments of innateness depend crucially on the range of environments chosen, I will argue that the reference to normalcy should be eliminated altogether when it comes to cognitive capacities (barring the minimal sense of normalcy required for the proper functioning of the organism, as explained at the end of the previous section).

[5] Ariew ([1999]) presents a counterexample to Stich's disease model, due to Wendler [1996], which also brings out the problems with relying on normalcy in this connection. However, neither Ariew nor Wendler discuss the triggering model of innateness.

Just as Stich's disease model was eliminated in favor of the triggering model, I will try to eliminate the canalization model by showing that it suffers from a fatal defect (a reference to normalcy) not found in the triggering model.

As in the case of the disease model, there is a connection between the implasticity model and the triggering model of innateness. If we say of a trait that it is canalized or implastic, this implies that for a wide range of environments, the output is roughly the same. This means that there is relatively little which is contributed by the environment itself, which in turn means that there is a relatively large innate contribution. To use a simplified example, suppose that no matter what the ambient temperature in a variety of different environments, the heat gauge on the dashboard of my car shows that it has overheated after I have driven it for a certain limited period of time. If the car overheats in a wide range of environmental conditions (uphill, downhill, winter, summer, and so on), this is equivalent to saying that the overheating is highly canalized or implastic. This in turn suggests that the environmental stimulus is playing a minimal role in determining the car's state of heat. That is precisely the idea behind the triggering model of innateness: the environment acts as a mere trigger in generating the output. Thus, this simple example can serve to outline the relationship between canalization and the triggering model of innateness. One can also run the inferential sequence in the other direction. If I were to discover that a minimal amount of driving would trigger overheating, I would have reason to assume that a wide range of driving conditions would result in overheating. This means that the car is likely to overheat in a broad range of environmental conditions. That is equivalent to saying that the overheating is implastic or canalized.

The upshot of these considerations is that the notions of canalization (or implasticity) and environmental triggering (or impoverishment) are indeed linked. That is not to say that the notions of implasticity of output and impoverishment of input are necessarily linked, but rather that given certain plausible facts about the world, there would seem to be a way of inferring one from the other. The difference is that in using the latter, unlike the former, we need not specify a range of 'normal' environments. What we do need to be able to do is to measure the comparative informational content of input and output.

To make the connection between the two models clearer and to gain some more insight into the features associated with each, I will now respond to an argument that innateness and implasticity are unrelated. Fiona Cowie ([1999]) charges that there is no relation between implasticity and innateness, specifically on the triggering construal of innateness. As she puts it, 'the fact that the outputs of learning might be thoroughly underdetermined by the available environmental information (as poverty of the stimulus arguments contend) is quite consistent with any amount of plasticity in the learning process itself' (*Ibid.*, p. 46). To support this point, she cites the example of two supposedly innate capacities, one of which is allegedly induced by a highly plastic process while the other comes about as a result of a highly implastic process. The second example is not in dispute, precisely because I have been arguing the link between innateness and implasticity. I only need to respond to the first example, which is the familiar one of Meno's slave boy. According to Cowie's retelling, the input that gives rise to the boy's ability to produce the geometric proof is *impoverished* yet the process of acquisition is *plastic*. The boy's competence is plastic because it is highly sensitive to variation in the environment. Unless the environment contains Socrates in dialectical mode, the acquisition of geometrical beliefs will simply not occur: 'take Socrates' questioning out of the picture, and the boy will remain happily ignorant of geometry' (*Ibid.*, p. 47). Yet, Cowie maintains, the stimulus is impoverished and the beliefs manifested by the slave boy are thought to be innate. Hence she concludes that innate beliefs can be highly plastic.

There are two things to be said about Cowie's argument. First, the choice of example here is unfortunate, for it is a contested matter whether Plato's dialogue demonstrates the existence of innate geometrical beliefs on the grounds that they can be triggered by an impoverished stimulus. The exchange between Socrates and the slave boy is notorious for its leading questions, its explicit introduction of novel concepts, and its copious supply of indispensable hints. Unless it can be assumed that this is a genuine case of innate understanding triggered by an impoverished stimulus, Cowie's argument is not valid. In other words, one could agree with Cowie that the slave boy's competence is indeed *plastic* (highly sensitive to Socrates' presence), but argue that Socrates provides the slave boy with a *rich* stimulus and that the boy's resultant grasp of geometry is not innate but learned. Far from presenting us with a plastic output accompanied by an impoverished input, the example arguably describes a plastic output and a rich input.

But there is more to be said about this case. Cowie's argument derives its initial plausibility from the fact that she has not specified the range of environments relative to which the judgment of plasticity is made. The geometric beliefs acquired as a result of the Socratic method are made to appear plastic only because we have failed to consider other processes of acquisition in other environments. The boy's beliefs may seem plastic when contrasted with the slave boy's usual environment, presumably one in which he receives little instruction on anything but household duties. In this context, the presence of Socrates is crucial to his acquisition of geometric beliefs. But these beliefs might seem somewhat implastic when contrasted with a typical schoolchild's environment. A theorist who wanted to use the example from the *Meno* to show that geometrical information was indeed (partly) innate might point out that there is a relatively wide range of learning environments from which one can acquire at least some of the geometrical knowledge that Socrates purveys. One can pick up knowledge of basic geometry (say, such concepts as length, area, square, rectangle, and so on) in an array of different types of school lessons and with little in the way of spoon-feeding or rote learning. This shows that the acquisition process for geometry is indeed relatively *implastic*, given a plausible specification of the range of environments, and may therefore contain an innate component. Therefore, despite Cowie's insistence to the contrary, Plato's argument in the *Meno* can be used to illustrate the link between innateness and implasticity, once it has been suitably relativized.

Let us now summarize the response to Cowie's alleged counter-example. First, I argued that Socrates' questioning of the slave boy was not a *prima facie* case of an impoverished stimulus, since it is actually quite rich in pedagogical hints. Therefore, it may be claimed that a plastic competence is indeed correlated with a rich stimulus in this case. But a second glance at the example reveals that, when it is compared with a certain range of learning environments, say an array of standard classrooms, the acquired competence in the slave boy's case might also be said to be relatively implastic (since the same competence can be acquired in multiple ways). However, these differing interpretations of the same example immediately raise a larger problem, namely that of relativism. When viewed one way, the input in the *Meno* case appears plastic (Socrates appears relatively important to the resultant body of information); when viewed another, it seems implastic (since it is capable of being acquired in many other contexts, e.g. a variety of school lessons). If one tries to respond by appealing to normalcy, one is again foiled by the vagueness of this notion and the lack of a clear guideline for applying it in this context. Does the normal range of environments include the slave boy's own domestic environment (arguably abnormal as pedagogic environments go), or that of a standard schoolchild (arguably abnormal for an average Athenian slave)? There seems to be no privileged way to specify normalcy for the purpose of identifying innate cognitive capacities. The judgment as to the plasticity of the cognizer's competence is dependent on the assessment of normalcy; this means that we are plagued with a disastrous relativism in making the judgment of plasticity. Given that I have argued that the implasticity model is closely linked to the triggering model, I need to show that the problem of relativism does not arise for the triggering model. To do so, I must demonstrate that there are ways of measuring the relative informational content of input and output that are not relative and do not appeal to normalcy. If this attempt is successful, we can safely reject the canalization model in favor of the triggering model.

5 Measuring poverty

The dilemma presented above is an instance of a more general problem well known to geneticists, population biologists, and others who are interested in gauging the relative influence of nature and nurture on a given phenotypic trait. When one considers an individual organism and attempts to assess the relative contribution of nature and nurture to the value of some trait for that individual, the judgment depends crucially on the population relative to which one compares that individual. For example, consider the height of a certain corn plant.[6] If we want to know how genes and environment have affected its height, we might vary the genotype and the environmental conditions and determine the average height for each gene-environment pair. We ask: would changing the environment lead the plant's height to depart more from its actual value than changing its genes? If the answer is affirmative, then the environment is a more powerful influence than the genes; if not, then genes are more important.

But notice that when the question is posed in this manner, we must make a crucial decision concerning what genes the plant *would* have had and what environments it *would* have been found in. Depending on how we specify the counterfactual possibilities, we will emerge with a different answer to the question of which is more important to height, environment or genes. That is why the choice of environments considered 'normal' (in some sense) is crucial to the judgment as to whether nurture or nature is more important. However, I will argue in this section that when it comes to innate *cognitive* capacities, the question of normalcy (beyond what is needed for the organism to function) can be obviated or avoided by focusing on the informational content of the stimulus relative to the resultant cognitive capacity.

When we ask whether, and to what extent, height is innate in corn plants, we are effectively asking whether genes are more important than environment in determining height. There is a determinate answer to this question, but only relative to a given population. In particular, we look at those plants that have the same genes but different environments versus those that have the same environment but different genes. Relative to one population, it may be that a corn plant Q has the same height as a plant with the same environment but different genes, so that in this case environment seems to play more of a role. But relative to another population, Q might have the same height as a plant with the same genes but a different environment, so in this case genes can be said to play more of a role. This situation is illustrated by Table 1 (adapted from Sober [1988]).

[6] In discussing this case, I am relying on the discussion in Sober ([1988]), as well as on Lewontin ([1974]).

Table 1

	G_1	G_2	G_3
E_1	x_{11}	x_{12}	x_{13}
E_2	x_{21}	x_{22} (Q)	x_{23}
E_3	x_{31}	x_{32}	x_{33}

In this example, population I (indicated by a solid line) consists of specimens of two genotypes (G_1, G_2), each of which is found in two different environments (E_1, E_2). There are four possible gene-environment combinations, each with a value for mean height (x_{ij}). Population II (indicated by a broken line) also consists of two genotypes (G_2, G_3) in two environments (E_2, E_3). In the case described above, we imagine that $x_{12} = x_{22} = x_{23}$ (and that at least some of the other values for x_{ij} are not identical). If we are interested in x_{22} (the height of corn plant Q), then relative to population I, environment made no difference, so genes are the factor that made a difference to height. By contrast, relative to population II, genes made no difference, so environment is the factor that made a difference to height. Ordinarily, one way around this relativity is to consider the population that contains the 'normal' or typical range of genotypes and environments for corn plants. Thus, population I might contain another commonly occurring genotype (G_1) and typical environment (E_1). By contrast, population II might contain a less commonly occurring genotype (G_3) and unusual environment (E_3). If that is the case, we are able to conclude that, over a range of 'normal' environments and genotypes, genes make more of a difference to the height of corn plants than environment.

Is there a way around this type of relativization to 'normalcy' in the case of innate cognitive capacities? Let us take a much-studied and relatively simple case—birdsong in different species of birds. In several decades of research, investigators have made claims of the following sort: in species A, isolation-rearing alters the ability of birds to develop adult song, whereas in species B it does not. On the basis of this result, they tend to conclude that birdsong is more innate in species B. But here, too, one might say that relativization affects the conclusion. Although it seems as though genes were more important in the development of birdsong for species B, it might be the case that if one looked at a third environmental factor (deafening) and a third species (C), one would get a different answer. Suppose that deafened birds from species B fail to develop a normal adult song. Meanwhile, suppose that birds from species C develop normal adult song even when deafened. When

Table 2

	G_1 (species A)	G_2 (species B)	G_3 (species C)
E_1 (isolation)	x_{11} (no song)	x_{12} (song)	x_{13}
E_2 (non-isolation)	x_{21} (song)	x_{22} (song)	x_{23} (song)
E_3 (deafening)	x_{31}	x_{32} (no song)	x_{33} (song)

we compare species B to species C over the environmental conditions mentioned (non-isolation, deafening), it seems as though the environmental factor (deafening) rather than the genetic factor was more important for the development of normal adult song in species B.

If we draw an analogous table (Table 2), we can ask the same question as we did above: to which population should we compare birds from species B who are reared with conspecifics? Again, if we compare them with population I (indicated by a solid line), it seems as though genes played a larger role, since the isolated B birds developed the same song as the non-isolated, socially-reared B birds. But if we compare them with population II (indicated by a broken line), it seems as though environment played a more important role in the development of adult song, since the deafened B birds failed to develop the same song as their non-isolation-reared conspecifics, whereas members of species C developed song even when deafened. Note that in this case, there does not seem to be a way of specifying the 'normal' population. Both environmental factors (isolation, deafening) are in some sense 'abnormal', and the genotypes involved are those associated with different species rather than different strains within the same species, so the question of normalcy does not arise. (There are interesting parallels here with the situation in the *Meno*, as described in Section 4.)

In this case, I propose that a natural remedy is to compare the environmental stimulus directly with the songs of the adult birds. While the environment seems less important for species B than for species A (it develops the usual adult song even in isolation), it is also true that some environmental cues are important for species B as well (it does not develop adult song when its hearing is impaired). In such cases, researchers conclude that auditory feedback is needed for the normal development of adult birdsong in species B, though not exposure to the song of conspecifics. It is safe to say that there is an innate endowment in the case of species B but that it requires some triggering (auditory feedback, but not the song of conspecifics). We are able to emerge with this conclusion because we judge that the environmental stimulus is impoverished relative to the resulting competence. It is not that we are relying on a specification of the 'normal' environments of the birds. Rather, in isolation rearing, the stimulus is impoverished relative to the resulting competence; in deafened birds it is even *more* impoverished. Thus, in the case of cognitive capacities, we have a natural way of comparing the trait to the environment, by comparing the strength of the environmental stimulus to the output (cognitive capacity). The fact that informational content is involved gives us a method for determining the environmental contribution to the resulting competence. At one point, in discussing corn plants, Sober states that we are unable to compare the relative contribution of genes and environment to the height of the plants because there is no common currency for their contributions: 'there are no such things as height particles' that are contributed by each ([1988], p. 312). While it is true that in the case of cognitive capacities, there are no informational particles, we do have some way of making relative judgments of informational content when comparing environmental stimulus and resultant cognitive competence. That is why we can safely say that there is a strong innate endowment in species B (stronger than in species A, but not as strong as in species C), which, however, is dependent on certain environmental cues like auditory feedback for it to manifest itself.[7]

Indeed, in trying to determine innate cognitive endowment, we sometimes do not even vary the genotype. We just look at a single species in two different environments, for example flycatchers reared in isolation versus those reared in the wild, or rats reared in darkness versus those reared in light. There is no need to appeal to 'normal conditions' (indeed it is positively misleading, as argued in Section 2); we merely compare the information available in the environment to the resulting competence in each case. We sometimes go further than this, and conclude that a cognitive capacity is partly innate without making any reference to alternative environments or to alternative genotypes, as in the case of humans and capacity to use language. Here, we appear to be making a direct judgment as to the informational content provided by the stimulus relative to that found in the resulting competence.[8] Notice that we are not making a comparative judgment in this

[7] Sometimes we are interested in comparing *different types* of behavior or cognitive competence within the same species. Is it legitimate to do so? Can we say that birdsong is more innate (say) than nest building, but less innate than mating behavior? It is not clear that we can really make a direct comparison here. We can (and do) say that learning to speak language is more innate than learning to read it, or more innate than calculus. Here, what we seem to be doing is thinking of each of these capacities as a skill comparable in complexity and ranking them on the basis of the strength of the stimulus sufficient to yield competence in each case. But such judgments are precarious at best.

[8] A more detailed story would take into account norms of reaction, as in Lewontin ([1974]). It seems safe to say that for contentful or informational states, the norms of reaction are likely to be roughly additive or linear, i.e. the more ambient information from the environment the more information absorbed, at least up to a saturation point. Note that this does not apply to a

case, but merely asking about a given cognitive capacity: how innate is it? Such a judgment presupposes a direct comparison of input and output in a particular case. Though it can be done, it will remain uncertain in the absence of a precise way of measuring informational content. This way of understanding innateness in the case of cognitive capacities is more successful in delivering *comparative* assessments of innateness rather than in determining the degree of innateness of any particular cognitive feature, but it is also capable of delivering non-comparative judgments in some circumstances.

Although there is no exact way of measuring the informational content of the trigger relative to the resultant cognitive capacity, there are ways of estimating the relative informational content of input and output. The above example from the birdsong literature illustrates a common strategy *across* genotypes; another example will help to illustrate another strategy *within* genotypes. Researchers working on infants' understanding of some features of the physical world may find it difficult to dismiss outright the possibility that these abilities are acquired as a result of extensive exposure to events in the physical world. Nevertheless, they can compare *different aspects* of infants' apprehension of basic physical principles in order to try to determine which have a more substantial innate endowment. Since infants have an earlier understanding of the continuity and solidity of objects (at least as early as 2½ months) than of the effects of gravity and inertia (6 months), Spelke ([1991]) has conjectured that infants have a more substantial innate endowment when it comes to the former than to the latter. She bases this conclusion on the fact that infants are exposed roughly equally to these different aspects of the physical domain and that they have roughly equal perceptual evidence for each (Spelke [1991], p. 161). Effectively, therefore, the environmental contribution cancels out, enabling us to make a comparative assessment of the innate contribution.

What is essential to the judgment of innateness in a cognitive context is the nature of the stimulus and its informational impoverishment or richness relative to the competence of the organism. In judging the innateness of contentful mental states, we are guided by the degree of impoverishment of the input relative to the output. The triggering model of innateness says that a contentful cognitive state is innate to the degree that it *would* emerge as a result of an impoverished environmental stimulus relative to the content of the cognitive state. At this point, a question should be addressed that arose when this model of innateness was first proposed (see Section 2). It seems as

cognitive capacity like IQ, which is not a contentful or informational mental state, and cannot therefore be treated similarly. Block ([1995], p. 105n; original emphasis) hints at this point: 'What psychologists usually have in mind when they say that aspects of syntax are genetically determined [. . .] or that aspects of the concept of an object are genetically determined is that the source of the *information* that people end up with is the genes. This model does not apply to IQ.'

though inductive generalizations based on empirical evidence exceed in content the stimulus upon which they are based; yet they are paradigmatic instances of non-innate beliefs, at least on the traditional understanding. This apparent anomaly can be accounted for by locating the innateness debate in its polemical context. The first thing to note is that it may well be the case that inductive and associative principles are at least in part innate. This means that beliefs formed on the basis of such principles have a content that is supplied in part by the cognizer. However, as many commentators on the contemporary innateness debate have noted, empricists are 'up to their necks' in such innate learning principles.[9] Therefore, the content contributed by these principles is usually factored out in considering questions of innateness. We are generally interested in discovering *what more* (if anything) is contributed by the cognizer in determining what is innate. Thus, for polemical reasons, the excess content contributed by those learning principles accepted by empiricists is simply ignored in an estimation of innateness. Since it is not a bone of contention among nativists and empiricists, the portion of the content of inductive generalizations that is contributed by inductive learning principles, while it may well be innate, is usually bracketed in estimating the degree of innateness of the output.

6 Assessing innateness

I have argued that the innateness of some cognitive capacities should be understood along the lines of a triggering model made explicit in Stich ([1975]), a model based on a conception of innateness with an illustrious history from Plato to Chomsky. I began by discussing two models of innateness proposed by Stich—the disease model and the triggering model. After showing that the disease model was problematic because of a vague reference to 'normalcy', I showed that the model can be replaced by the triggering model without loss of explanatory value. The triggering model explicates innateness in terms of the relative content of the environmental stimulus and the cognitive competence caused by the stimulus. I then went on to argue that more recent models of innateness due to Sober and Ariew were plagued by similar problems as Stich's first model. Sober ([1998]) talks about 'the appropriate range of environments' relative to which the degree of innateness of a trait is determined, concluding that the appropriate range is likely to be determined pragmatically. Meanwhile, Ariew ([1999]) makes reference to 'normal' environments of acquisition. Although there is a link between implasticity models and the triggering model, the latter is not afflicted with the problem of relativization to populations or environments

[9] The phrase comes from Quine ([1976], p. 57). Though he uses it with reference to behaviorists, it applies *a fortiori* to empiricists.

that arises in connection with the former. Finally, I argued that the problem of measuring output relative to input, which *is* faced by the triggering model, is a tractable one and can be solved, albeit in a rough and ready way.

One of the advantages of the triggering model of the innateness of cognitive states is that it squares nicely with the ur-argument for innateness, namely the argument from poverty of the stimulus. But it might be objected that if innateness is understood in terms of stimulus impoverishment, then the poverty of the stimulus argument ceases to be an argument *for* innateness and becomes instead an explication *of* innateness. Surely, it may be said, we should have an independent understanding of innateness, and then argue for it on the basis of the poverty of the stimulus. The response to this objection relies on the fact that this is a *dispositional* analysis of innateness. Consider what it would be to have a direct handle on the innateness of our cognitive capacities. It might be said that once our knowledge of genetics is sufficiently advanced, we will be able to read the informational content of our innate endowment directly from the information encoded in our genes. While this may be feasible some time in the future, our present understanding of genetics is far from making this possible. Moreover, philosophers of biology have argued that the notion that information about the phenotype can be read off of our genes, even when it concerns fairly simple traits (e.g. eye color or number of bristles for *Drosophila*), is fundamentally misguided.[10] The argument would seem to apply with greater force for the encoding of information concerning the content of our cognitive states. Therefore, in the absence of some direct method of inspection, the notion of innateness, when applied to cognition, is an example of a dispositional concept. Its content is given by a dispositional explanation, until such time as the grounds of the disposition are adequately known (if ever). This is not a dormitive virtue explanation, since we have definite guidelines for ruling that the stimulus is indeed impoverished, and for rating degrees of innateness. Moreover, showing that the stimulus is impoverished in any given instance is far from a trivial matter. This allows us to uphold the close connection between the triggering model of innateness and the argument from the poverty of the stimulus, without trivializing either.

It should be emphasized that this is not meant to be a *definition* of the notion of innateness as applied to contentful cognitive states. Rather, it is meant to be a theoretical explication of that notion. According to this proposal, a belief (concept, idea, capacity) may be considered to be innate to

[10] This point about genetic coding has been made recently by Godfrey-Smith, who asserts: 'There are good reasons for claiming that proteins are *made by being coded for*, and hence that a specific gene codes for a particular protein. But once we consider the complex traits of whole organisms, such as camouflage or cooperative behavioral tendencies, none of these traits are coded for by the genes' ([2000], p. 35; original emphasis).

the degree that it would emerge as a result of an impoverished stimulus. It may be objected here that if the belief emerges in the presence of a rich environmental stimulus, we cannot conclude that it is not innate. For it could be that the belief would have emerged even though the stimulus had been weaker, or indeed absent altogether. The response to this objection is that this proposal does not simply *equate* degree of innateness with degree of impoverishment of the stimulus. The point can be supported by means of an analogy. Suppose we give a dispositional account of fragility that makes this dispositional property a matter of degree, so that an object is fragile to the extent that it would break on the application of a weak force, and the weaker the force the more fragile the object. Then, imagine that we observe that a certain glass is crushed by a sledgehammer, which delivers a large force. We cannot conclude from this evidence alone that the glass is not fragile. We may never know whether the original glass was fragile, or else we may be able to determine that an identical glass broke on applying a smaller force, and conclude on that basis that it is indeed fragile. Similarly, in the case of an innate belief: if the environmental stimulus is not impoverished, that does not imply that the related belief is not innate. A dispositional account crucially involves a *hypothetical* conditional: we need to determine whether the belief *would* emerge in the presence of an impoverished stimulus (which is not always an easy thing to do in practice).

Finally, cognitive content or informational content cannot be measured directly and precisely. While bare information *can* be measured according to the principles of mathematical information theory, there is an important gap between information in the latter sense and full-blown content. Far from equating the two or assuming that cognitive content is similarly measurable, the proposal under discussion merely holds that assessments of information are often possible and amenable to empirical investigation. In most of the examples discussed above, we make rough-and-ready relative judgments of innateness based on uncontroversial assumptions regarding the comparative informational content of the input (on the one hand) and of the resultant cognitive state (on the other). We can assume, for example, that birds raised in isolation are more informationally-deprived than socially reared birds, or that deaf children raised by non-signing parents have less linguistic information than those raised by parents who use sign language. Similarly, we can assume that children who have the concepts of object permanence and gravity have more information than those with the concept of object permanence alone. Moreover, when it comes to informational content, there are important differences between signals with semantic content (e.g. sentences) and those without such content (e.g. physical events), as there are between full-blown propositional attitudes (e.g. beliefs) and cognitive capacities without propositional or semantic content (e.g. birdsong). But despite these differences, estimates of the relative amount of information in input and output can be made, especially (though perhaps not exclusively) within particular cognitive domains (e.g. birdsong, language, spatial cognition).[11]

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[11] Elsewhere, I have argued that there is an epistemic or evidential relation between innateness and domain specificity. See Khalidi ([2001]).

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