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Scientists' Concepts of Innateness: Evolution or Attraction?

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The concept of innateness is an important component of *folkbiology* (Medin and Atran, 1999), the body of beliefs that people spontaneously rely on to make sense of their biological environment (reproduction, growth, decay, death, etc.). The innateness concept leads people to distinguish two kinds of biological traits: those that are innate and those that are learned. Innate traits are expressions of an organism's nature: they develop spontaneously and reliably (except under "abnormal" or "unnatural" conditions); they are shared by all members of the species or its natural subclasses, like males or juveniles (if an individual lacks the trait, they are "deformed" or "abnormal"); and they are functional in that they contribute to the life of the organism. Acquired traits, by contrast, are imposed, as it were, from the outside, and they are found in some, but not all, conspecifics.

The idea that members of a species share an essential nature that explains the typical character of the species has been attributed by philosophers to the influence of Plato and Aristotle (Hull, 1965). However, it is likely that these philosophers, like early naturalists, were merely codifying the common sense of their local culture (Atran, 1990). This simple framework for thinking about biological development allowed early thinkers to make sense of basic observations such as the tendency for offspring to resemble parents or for members of the same species to exhibit similar behaviors. It had a practical, heuristic value in the domestication of animals and selection for preferred traits. It predicted, for example, that dogs could be selected for loyalty, but not for loyalty to a particular family: The former is innate, the latter acquired. It is therefore not surprising that this prescientific distinction is deeply entrenched in folkbiology.

However, the concept of innateness appears to be incompatible with our scientifically informed understanding of evolution, development, and heredity.

We now recognize that all traits develop as a result of the interaction between genetic and environmental factors. It is therefore misleading to ask, "is this trait innate or acquired?" The more appropriate question is "how do specific genetic and environmental factors interact in the development of this trait?"

Moreover, as biologists uncover details about how certain traits develop, a further problem with the folk concept has become apparent. According to this concept, innate traits are expected to have three basic properties: developmental fixity, species typicality, and biological function. Thus, the presence of one property, on the folk view, is taken as evidence for the presence of the other two. For example, if a trait is developmentally buffered against some environmental factor, this was historically taken to suggest that it is also species-typical and functional. Likewise, traits that are species-typical were expected to be developmentally buffered and functional, and so on. However, we now know that these three properties often come apart in nature. Just consider the Bluehead Wrasse (*Thalassoma bifasciatum*), which routinely changes sex from male to female (and back again) in response to the ratio of males to females in its social environment (Warner and Swearer, 1991). Such examples illustrate that a species-typical and (presumably) functional trait can be highly phenotypically plastic (not fixed). Likewise, other traits which are more developmentally stable, such as song-structure in some birds, are variable across a species' range (Benedict and Bowie, 2009). Other behaviors are induced by exposure to certain chemicals during development, and could become typical without being functional (Zala and Penn, 2004). A problem with the vernacular concept of innateness is that it promotes unreliable inferences from one property to another.

Numerous scientists engaged in the study of behavioral development argued that the concept of innateness skews our understanding of development and have called on scientists to abandon it (e.g., Lehrman, 1953; Hinde 1968; West, King, and Duff, 1990), a call endorsed by some philosophers (Griffiths, 2002; Mameli and Bateson, 2006; Stotz, 2008; Griffiths and Machery, 2008). Despite this criticism, the concept of innateness is alive and well in many areas of science. Mainstream developmental psychologists theorize regularly about whether a trait is innate or about the innate foundations of the mind. In her influential book, *The Origin of Concepts*, Susan Carey writes as follows (2009, p. 67; emphasis added):

> I agree with these writers [Renée Baillargeon, Randy Gallistel, Rochel Gelman, Alan Leslie, and Elizabeth Spelke] that the cognition of humans, like that of all animals, begins with highly structured *innate* mechanisms designed to build representations with specific content.

Similarly, linguists of a Chomskian persuasion hold that people can learn to speak a language because of the innate endowment of the mind. Baker describes this psychological endowment as follows (2001, p. 13; emphasis added):

> By their very nature, children seem to be especially equipped for language learning. No one yet knows exactly what this special equipment consists of. It probably involves knowledge of what human languages are like and of what kinds of sounds and structures they might contain, together with strategies for recognizing those sounds and structures. Linguists call this *innate* head start "universal grammar."

Evolutionary behavioral scientists also appeal to the notion of innateness. Boyd and Richerson refer to the "*innate* predispositions and organic constraints that influence the ideas that we find attractive, the skills that we can learn, the emotions that we can experience, and the very way we see the world" (2005, p. 8; emphasis added). And so do many philosophers, such as Fodor in his classic article "The present status of the innateness controversy" (1981, 258; emphasis added):

> It does seem to me that Chomsky's demonstration that there is serious evidence for the *innateness* of what he calls "General Linguistic Theory" is the existence proof for the possibility of a cognitive science.

Importantly, it is not only nativists who use the notion of innateness in a scientific context. Empiricists, who assert that many traits are not innate but acquired, often use this notion too. For instance, Prinz describes his target in *Beyond Human Nature* as follows (2012, p. 2; emphasis added):

> By ignoring cultural variation, researchers end up giving us a misleading picture of the mind. We end up with the idea that psychology is profoundly inflexible. This outlook grossly underestimates human potential. It leads to the view that our behavior is mostly driven by biology. Mainstream cognitive scientists give the impression that human traits are "innate", "genetic" or "hardwired."

Why do these scientists and philosophers adhere to a concept[1] that has been so thoroughly criticized? It may be that while scientists, like laypeople, use the word *innate*, they do so in order to express a different, less objectionable (if at all) concept of innateness. The term *innateness* is preserved because the new, scientific, defensible concept of innateness is a revision of the problematic concept of innateness: It is a "successor concept" (Machery, 2017a). An alternative hypothesis is that some researchers cling to this concept for less epistemically justified reasons. It is possible that even sophisticated researchers occasionally revert, perhaps unwittingly, to using the folk concept. On this view, there is no revised conception of innateness that scientists share. Rather, there is a prescientific folk concept that occasionally influences their thinking, presumably in ways that are misleading.

The goal of this chapter is to investigate what scientists mean by *innateness* in order to find out whether they have developed a successor concept or whether they are still relying on the vernacular concept of innateness. To meet this goal, it is not sufficient to ask scientists what they mean by *innate* or to report their explicit theorizing about innateness. Concerning the former point, scientists may have false beliefs about the very concept of innateness they happen to use; indeed, they are probably incentivized to claim that they mean something different from what laypeople mean. Concerning the latter point, scientists may have developed a particular understanding about what innateness is, but this understanding is not at work in their everyday use of the term *innate*: In their most reflective moments, scientists may mean one thing, while using another concept in their everyday judgments about innateness. We will call the concept of innateness scientists happen to use when they judge that something is or isn't innate their *effective* concept and the concept that is expressed when they theorize explicitly about innateness their *explicit* concept. Using this terminology, our concern then is that scientists' effective concept might not be their explicit concept.

How can we identify the characteristics of scientists' effective concept of innateness? Instead of asking scientists what they mean and instead of looking at their writings about innateness, we propose to examine how they use the word *innate* and infer the content of the expressed concept from these uses (Hyundeuk and Machery, 2016; Machery, 2017b). To do so, we could examine the natural occurrences of this word in scientists' writings, as do linguists working with corpora, but this approach has well-known limitations (Griffiths and Stotz, 2008). Alternatively, we can elicit uses of *innate* and infer scientists' concepts from these uses. In this chapter, we will follow this experimental methodology in order to characterize the content of scientists' effective concept of innateness.[2]

Here is how we proceed. In the first section titled "The vernacular concept of innateness," we review the experimental work on the vernacular concept of innateness, which will form the background of the experimental work reported in this chapter. In "Two hypotheses about scientists' concept of innateness," we present two distinct hypotheses about scientists' concept of innateness: the conceptual ecology hypothesis and the attractor hypothesis. The section "Experimental study" describes our experimental work and our results. The next section "Scientific and folk concepts" discusses the significance of these results for the relation between folk and scientific concepts. Finally, "Innateness in science" delves into the significance of our project for the concept of innateness in science.

The vernacular concept of innateness

Following Griffiths (2002), we proposed in past research that the vernacular concept of innateness belongs to folkbiology, and we used psychological research on folkbiology to formulate hypotheses about the content of the concept of innateness (Griffiths, Machery, and Linquist, 2009; Linquist et al., 2011). An important component of folkbiology is the belief that biological traits are inherited at birth from genetic parents and that their development is relatively insensitive to the offspring's environment. The switched-at-birth experimental task has been used to examine this belief in children (e.g., Gelman, 2004): In this task, a vignette describes how a young animal (e.g., a young cow) is raised by members of another species (e.g., by pigs), and children are asked whether the animal would have the traits of its genetic parents (e.g., they are asked whether the young cow would moo) or of its adoptive parents. (This task has also been adapted to describe a child being reared by parents different from its genetic parents in various respects.) Research suggests that biological traits are thought to be transferred at birth, independently of the rearing environment. On this basis, we hypothesized that when laypeople say that a trait is innate, they view it as developing reliably independently of its environment. Psychologists have also emphasized the role of generics in folkbiology (e.g., Gelman, Ware, and Kleinberg, 2010). Generics are statements that, while expressing generalizations, do not contain quantifiers, such as "all" or "every." While tolerating exceptions, they are often understood as asserting that a property is widely shared for nonaccidental reasons by the members of a given class. Lay claims about species are often expressed by means of generics. On the basis of this body of research, we hypothesized that when laypeople say that a trait is innate, they view it as widespread among conspecifics. Finally, psychologists have identified a form of naïve teleology at work in lay thought (Kelemen and Rosset, 2009): laypeople ascribe functions to biological traits (as well as to other natural things). On the basis of this body of evidence, we hypothesized that when laypeople say that a trait is innate, they view it as having some kind of function. To summarize, we formulated three hypotheses about the content of the concept of innateness:

1. Fixity: A trait is more likely to be judged innate the more independent from its environment its development appears to be.
2. Typicality: A trait is more likely to be judged innate the more typical it is.
3. Teleology: A trait is more likely to be judged innate the more functional it is.

To clarify, we do not view fixity, typicality, and teleology as separately necessary and jointly sufficient conditions for a trait to count as innate. Rather, we view them as prototypical features of the concept of innateness; they characterize what a prototypical innate trait would look like, and a trait is more likely to be judged innate to the extent that it resembles this prototypical innate trait.[3]

To test our hypothesis about the vernacular concept of innateness, we developed a set of eight vignettes that varied whether a trait (birdsong) develops reliably, is typical, and has a function. Participants were then asked whether the trait is innate. Here is one of the vignettes we used:

> Birdsong is one of the most intensively studied aspects of animal behaviour. Since the 1950s scientists have used recordings and sound spectrograms to uncover the structure and function of birdsong. Neuroscientists have investigated in great detail the areas of the brain that allow birds to develop and produce their songs. Other scientists have done ecological fieldwork to study what role song plays in the lives of different birds.
>
> The Alder Flycatcher (*Empidonax alnorum*) is a migratory neo-tropical bird which breeds in southern Canada and the northern USA. Studies on the Alder Flycatcher show that the song an adult male produces does not depend on which songs they hear when they are young. Studies also show that different males in this species sing different songs. Furthermore, close observations of these birds reveal that the males' song attracts mates and helps to defend their territory. Scientists therefore agree that the bird's song has a real function, like the heart in humans.

On a 7-point scale, 1 meaning strongly disagree and 7 meaning strongly agree, how would you respond to the following statement?

> "The song of the male Alder Flycatcher is innate."

The seven other vignettes were variations based on this vignette. Participants were laypeople without any training in biology or psychology. In Study 1, they were presented with a single vignette (between-subjects design), while in Study 2, they were presented with the eight vignettes (within-subjects design).

While there were a few differences between the results of these two studies, these were largely congruent: Fixity and typicality had a strong influence on how strongly participants agreed that a trait is innate (how much they matter depends on the details of the experimental design), while, surprisingly, teleology had no significant impact on participants' judgments, at least not one that was detectable using our questionnaire. Importantly, the two properties of fixity and typicality independently influenced participants' judgments. For example, if a trait was presented as either fixed (and not typical), or typical (and not fixed), then respondents would be inclined to agree that the trait is innate in either case. We took this to reveal something important about the structure of the vernacular concept: that neither fixity nor typicality are regarded as necessary conditions for innateness.

Follow-up work has confirmed and extended these results (Linquist et al., 2011; see also Knobe and Samuels, 2013). One of the main goals of this follow-up work was to examine whether other expressions in contemporary English express the vernacular concept of innateness (or very related ones). Lay participants were presented with a set of eight vignettes based on the vignettes previously used. However, instead of using lay terminology, the vignettes involved more accurate, technical terminology. For instance, once of the vignettes read as follows:

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

Each participant saw four vignettes (four vignettes where the song is fixed or four vignettes where it is not fixed). Participants were asked the following question followed by one of the three following statements:

On a 7-point scale, 1 meaning strongly disagree and 7 meaning strongly agree, how would you respond to the following statement?

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

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

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

Answers to the innateness question replicated by and large the results of Griffiths, Machery, and Linquist, 2009. More interesting, answers to the "in its DNA" question matched our expectations about the concept of innateness extremely well, while answers to the "in its nature" question were hard to interpret. We interpret these results to suggest that laypeople use "innate" and "in the genes" to express the same, vernacular concept. More generally, the results help to establish the robustness of our earlier finding that the vernacular concept of innateness is well characterized by the three hypotheses we derived from the research on folkbiology (although teleology is less important than expected). In everyday English, the often used expression "it is in their genes" expresses this concept and draws a distinction between the traits that reflect the nature of an animal or a plant and the traits that don't. The expression "in their nature" is not very clear for contemporary speakers of English, while "innate" roughly maps onto the concept of innateness.

Our three-factor model is also convergent with a large body of work on genetic essentialism conducted in social psychology at around the same time (e.g., Haslam and Ernst, 2002; Dar-Nimrod and Heine, 2011; Haslam, 2011; Cheung, Dar-Nimrod, and Gonsalkorale, 2014). The congruence between the results of these two bodies of work can be seen in Table 8.1 (see also Stotz and Griffiths, 2018; Lynch et al., 2019).

Two hypotheses about scientists' concept of innateness

Earlier, we sketched two hypotheses to explain scientists persistent use of *innate* and other cognate terms, despite the widespread recognition that the vernacular concept is scientifically flawed. The first proposal stated that the vernacular concept has effectively evolved and become adapted to the particular demands of contemporary science. The alternative proposal stated that researchers are effectively stuck in an outmoded way of thinking, which is potentially counterproductive. In this chapter, we refine these hypotheses and draw connections to the literature on scientific theory change and cultural evolution. Both hypotheses agree that scientists' concept or concepts of innateness are

Table 8.1 Comparison between the genetic essentialism framework (GEF) and the three-factor model (from Stotz and Griffiths 2018, p. 61)

Genetic Essentialist Elements	Three-Factor Model of Animal Natures
(Dar-Nimrod and Heine, 2011)	(Linquist et al., 2011)
Immutable and determined: thinking about genetic attributions leads people to view relevant phenotypes as less changeable and predetermined	*Fixity*: phenotypes that are part of an animal's nature do not depend on the particular environment in which the organism is raised and are hard to change by environmental manipulations
Specific etiology: the tendency to discount additional causal explanations once genetic attributions are made	Traits are *either* expression of the animal's nature (and are expected to have the three features) *or* imposed by the environment (with opposite expectations)
Homogeneous and discrete: leads to a focus on the central identifying features that are common to all group members, drawing attention away from in-group differentiating features	*Typicality*: phenotypes that are part of an animal's nature are typical of the entire species or of some natural subset such as males or juveniles
Nature: phenotypes are perceived as a natural outcome (with positive normative associations)	*Teleology*: phenotypes that are part of an animal's nature serve some purpose (with positive normative associations)

derived from the vernacular concept of innateness. Both hypotheses also assume that the research summarized in "The vernacular concept of innateness" captures the important features of the vernacular concept of innateness. They disagree, however, about the relation between the vernacular concept of innateness and scientists' concept or concepts of innateness.

The first approach is inspired by Hull's (1988, Chapter 12) evolutionary philosophy of science, and an approach which Stotz and Griffiths (2004) have termed "conceptual ecology." According to Hull, theories evolve and are connected to one another by a process that shares many similarities with evolution by natural selection. Theories are related to one another by a process of descent, theories typically being modifications of preexisting theories. Not all modifications are successful: Some modifications allow a theory to better fit with its niche, where the niche of a theory includes the set of explananda it is brought to bear on, the interventions it allows scientists to make, and so on. Stotz and Griffiths (2004, see also Griffiths and Stotz, 2008) have conducted research in the same spirit, examining the "ecological" context of scientific concepts ("conceptual niches"). On their view, scientists modify their conceptual tools flexibly and adaptively to respond to theoretical and experimental needs, which vary across research communities and traditions. There are differences between these two approaches to scientific dynamics (for one, Hull focuses on theories, Stotz and Griffiths, on concepts), but both have the same consequence for scientists' concepts of innateness: We should expect variation across disciplines in how scientists conceptualize innateness. All these concepts derive from the vernacular concept of innateness (the ancestral concept) and have come to fit their particular scientific niche. We can then formulate the conceptual ecology hypothesis:

> *The conceptual ecology hypothesis*: The concept of innateness should vary across scientific disciplines or scientific traditions, depending on varying theoretical, explanatory, experimental, and practical needs.

The alternative attractor hypothesis is loosely inspired by Sperber's theory of cultural evolution: cultural attractor theory (Sperber, 1996; Claidière and Sperber, 2007). According to Sperber, what beliefs, concepts, values, desires, and so on people happen to embrace in a given culture is influenced and constrained, among other things, by evolved, universal psychological structures. This influence explains the similarities across cultures. We propose to extend some elements of this theory of cultural evolution to scientific concepts. We propose that the vernacular concept of innateness works as an attractor: Scientists tend to express this very concept by the word *innate*. So to speak, their thoughts are attracted by this concept, and it is difficult for them to develop an effective concept that differs from it. We can now formulate the attractor hypothesis:

> *The attractor hypothesis*: Scientists tend to think similarly about innateness across disciplines or scientific traditions because the vernacular concept of innateness influences their thoughts on the matter.

Thus, we must consider two competing hypotheses about the relation between the vernacular concept of innateness and scientists' concept(s) of innateness. In the remainder of this chapter, we test these two hypotheses experimentally.

Experimental study

Participants

Participants were scientists working in linguistics, psychology (including comparative, developmental, and evolutionary psychology), neuroscience, genetics, biology (including developmental and evolutionary biology), and ethology. In September 2010, in collaboration with Joshua Knobe and Richard

Samuels the coauthors of this paper contacted hundreds of scientists by email. The email we sent asked scientists to log in into a Qualtrics website in order to complete a short survey; they were also asked to forward the email to their colleagues, graduate students, and colleagues. In response to this email, 767 participants completed the survey. Out of those, 295 were randomly assigned to the study reported in this chapter. The remainder completed the studies conducted by Knobe and Samuels (reported in Knobe and Samuels, 2013). We excluded participants who did not complete the survey, leaving us with a sample of 232 scientists (Table 8.2).

Materials and procedures

Eight vignettes were constructed on the basis of our previous work on the vernacular concept of innateness (Griffiths et al., 2009; Linquist et al., 2011). Each vignette was about birdsong. The eight vignettes then varied whether birdsong was fixed, typical, and had a function. As in our previous work, we made sure that the content of each vignette was true and seemed plausible since scientists might be reluctant to make a judgment about implausible scenarios. We relied on the more technical sounding and more accurate formulation previously used by Linquist et al. (2011) since participants were scientists and likely familiar with such terminology. As an example, the Eastern Phoebe vignette describes a trait that is fixed, typical, and has a function:

The Eastern Phoebe (*Sayornis phoebe*) is a small, North American flycatcher. It can be shown by experimentally manipulating what young birds hear that the sequence of song elements produced by an adult Eastern Phoebe male does not depend on which sequences it hears when it is young. Furthermore, studies have shown that there is no significant interpopulational and interindividual variation in the sequence of song elements produced by Eastern Phoebe males. Finally, close observations of these birds reveal that the sequence of song elements produced by Eastern Phoebe males helps them attract mates and helps

Table 8.2 Participants' demographics

Gender	Language	Nationality (main countries)	Education
Male: 48%	English: 72%	USA: 55.7% Canada: 7.3% UK: 5.5% Germany: 4.8%	College degree: 17:3% MA: 24.3% PhD: 58.4%

them to defend their territory. Scientists therefore agree that the sequence of song elements produced by Eastern Phoebe males is an adaptation.

Participants were first presented with an accurate introduction about scientific research on birdsong:

> Birdsong is one of the most intensively studied aspects of animal behaviour. Since the 1950s scientists have used recordings and acoustic analysis to uncover the structure and function of birdsong. Neuroscientists have investigated in great detail the areas of the brain that allow birds to develop and produce their songs and hormonal influences on song production. Other scientists have done ecological fieldwork to study what role song plays in the lives of different birds.

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They were then presented with four out of the eight possible vignettes (all of them describing either a fixed birdsong or a nonfixed birdsong). The order of these four vignettes was randomized. Each vignette was followed by the following question:

> On a 7-point scale, 1 meaning strongly disagree and 7 meaning strongly agree, how would you respond to the following statement?
> "The sequence of song elements produced by a male Black-Capped Chickadee is innate."

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Participants were asked to respond on a 7-point scale, anchored at 1 with "Strongly disagree" and at 7 with "strongly agree." This mixed factorial design (between-subjects factor: fixity; within-subjects factor: typicality and teleology) follows Linquist et al., 2011.

Participants then completed a standard demographic questionnaire as well as a questionnaire reporting their disciplinary affiliation. Participants were allowed to check several options (e.g., developmental psychology and evolutionary psychology). We use their answers to this latter questionnaire in the analysis reported below. Finally, participants were asked to answer the question, "In your view, does the notion of *innateness* have any role within your field(s) of research?" on a 7-point scale anchored at 1 with "No," 4 with "In between," and 7 with "Yes."

Results

Our first task was to assign participants to disciplines. Because participants were allowed to check several options, we had to assign some of them to one of the options they had chosen. Before analyzing the data, we adopted the following rules:

1. Participants are classified as psychologists if they checked one of the psychology options (except for the "other" option, which was treated on a case-by-case basis).
2. Participants are classified as human behavioral scientists if they checked "evolutionary psychology" or "human behavioral ecology".
3. Participants are classified as experimental psychologists if they checked "social", "experimental", or "personality" psychologists and are not classified as evolutionary behavioral scientists.
4. Participants are classified as linguists if they checked one of the linguistics options (except for the "other" option which was treated on a case by case basis) and if they were not classified as psychologists.
5. Participants are classified as generative linguists if they checked the "generative linguistics" option.
6. Participants are classified as nongenerative linguists if they checked the "sociolinguistics" option.
7. Participants are classified as biologists if they checked one of the biology options (except for the "other" option, which was treated on a case-by-case basis).

In addition, we used participants' answers to the "other" option to classify a few additional participants in these categories.[4] Psycholinguists, anthropologists, and ethologists were classified as psychologists. Cultural anthropologists were classified as experimental psychologists. Evolutionary anthropologists were classified as evolutionary behavioral scientists. Cognitive linguists as well as linguists working on typology, applied linguistics, comparative linguistics, and documentary linguistics were added to the nongenerative linguistics category.

We relied on this disciplinary classificatory scheme for several reasons. First, we intended to compare scientists' concepts of innateness across broad disciplinary distinctions: The contrast between psychology, linguistics, and biology is meant to allow for this comparison. Second, within each of these broad disciplines, researchers within subdisciplines or competing approaches either have expressed very different views about the innate endowment of the mind or rely on the concept of innateness to a very different extent. Evolutionary psychologists use the concept of innateness extensively, while cognitive psychologists, social psychologists, and personality psychologists much less. Generative linguists tend to believe that key components of language are innate, while sociolinguists are skeptical. Finally, we were constrained by our small sample size: Many possibly interesting disciplinary groupings resulted in sample sizes that were too small to allow for meaningful quantitative analysis.

We first examine how scientists conceive of innateness across the three broadest disciplinary affiliations we distinguished. A mixed-design analysis of psychologists' responses (between-subjects factor: fixity; within-subjects factors: typicality and teleology) revealed a main effect of typicality ($F(1, 78) = 24.2$, $p < .001$; $\eta^2 = .24$) and fixity ($F(1, 78) = 47.6$, $p < .001$; $\eta^2 = .38$). The effect of typicality was significantly larger when the trait was fixed than when it was not fixed, although the effect size is small ($F(1, 78) = 4.6$, $p < .03$; $\eta^2 = .06$). Teleology was not significant ($F(1, 78) = 2.9$, $p = .09$; $\eta^2 = .04$). Figure 8.1 represents these results.

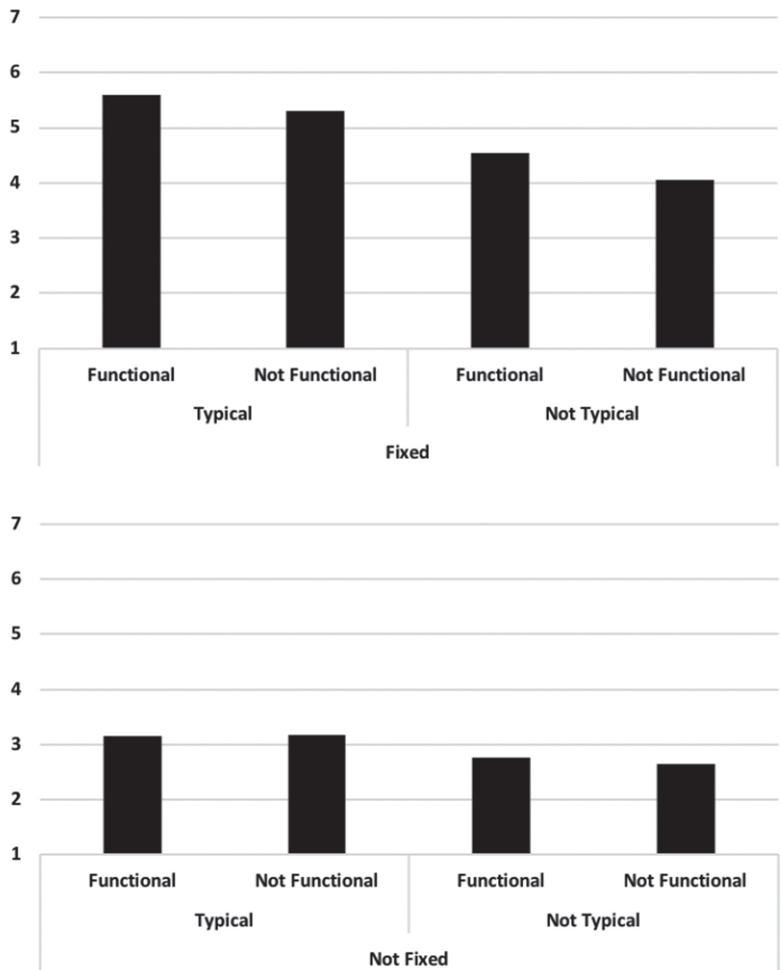

Figure 8.1 Psychologists' mean innateness judgments.

A mixed-design analysis of linguists' responses produced similar results. It revealed a main effect of typicality ($F(1, 46) = 11.2$, $p = .002$; $\eta^2 = .20$) and fixity ($F(1, 46) = 46.9$, $p < .001$; $\eta^2 = .51$). No interaction between typicality and fixity was observed. Teleology was not significant ($F(1, 46) = 1.4$, $p = .24$; $\eta^2 = .03$). Figure 8.2 represents these results.

A mixed-design analysis of biologists' responses produced again similar results. It revealed a main effect of typicality ($F(1, 24) = 8.0$, $p = .009$; $\eta^2 = .25$) and fixity ($F(1, 24) = 11.8$, $p = .002$; $\eta^2 = .33$). Teleology was not significant ($F(1, 24) = .5$, $p = .51$; $\eta^2 = .02$). Figure 8.3 represents these results.

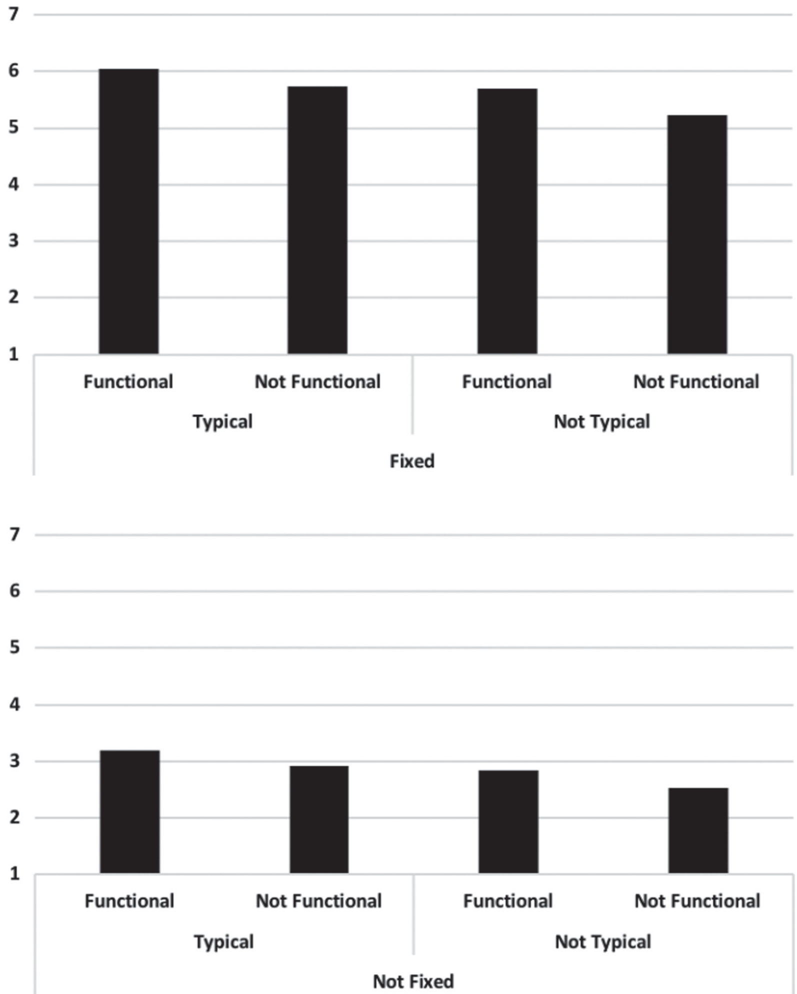

Figure 8.2 Linguists' mean innateness judgments.

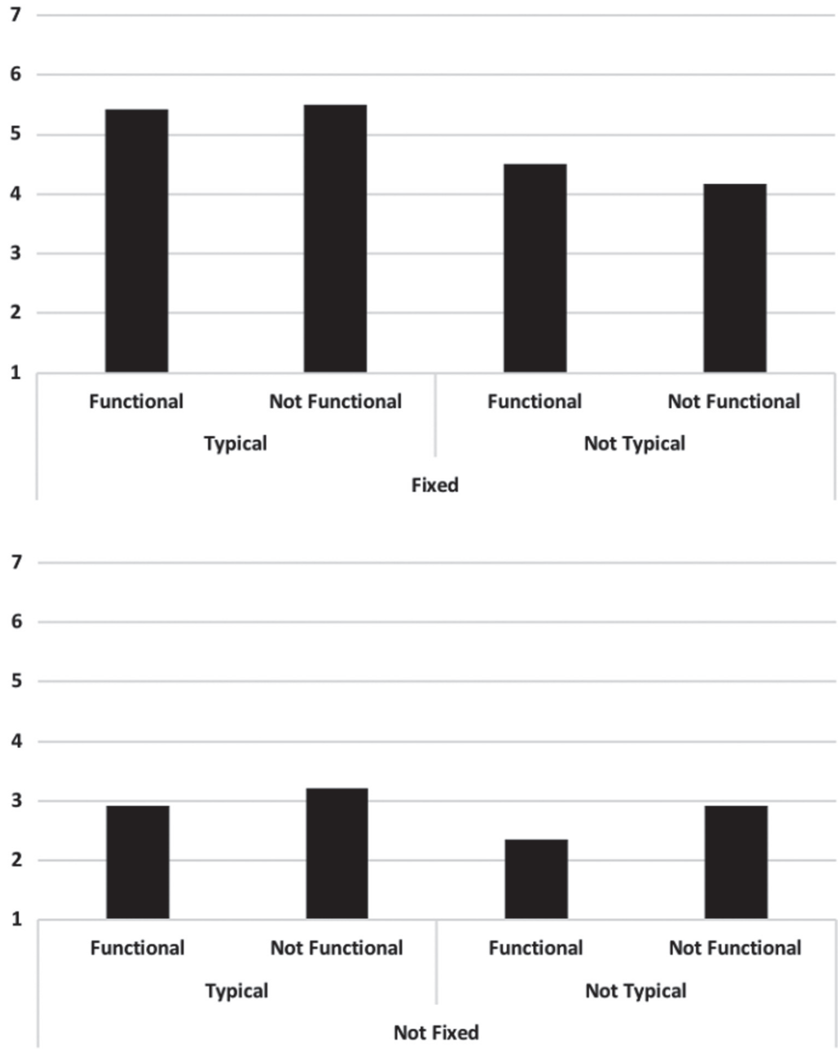

Figure 8.3 Biologists' mean innateness judgments.

We then compared whether the concept of innateness plays a role in research across these three areas. A one-way analysis of variance (ANOVA) established that the concept of innateness is not equally important in biology, linguistics, and psychology ($F(2, 24) = 6.3$, $p = .002$; $\eta^2 = .08$), with biology being significantly lower than both linguistics and psychology (Figure 8.4).

T-tests revealed that the mean response is significantly higher than the midpoint (anchored at "in between" between "no" and "yes") for both

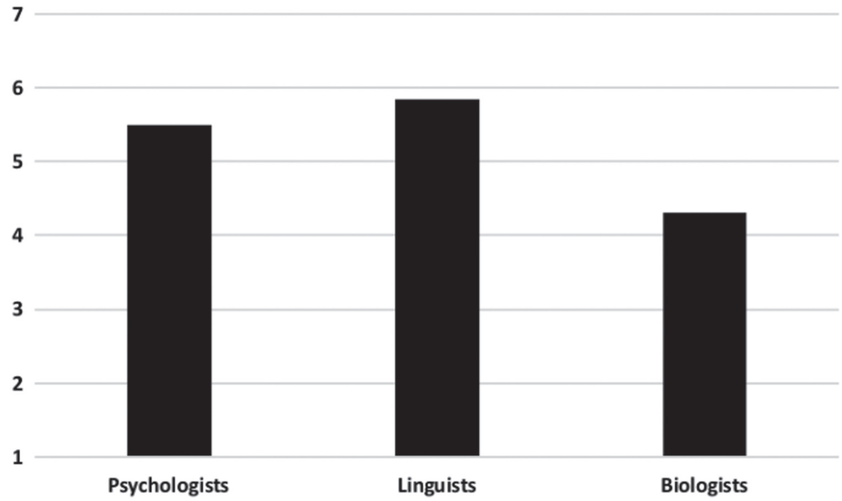

Figure 8.4 Judgments about the importance of innateness across disciplines.

psychologists (t(76) = 7.2, $p < .001$) and linguists (t(46) = 8.0, $p < .001$), but not for biologists (t(26) = .7, $p = .5$).

We now turn to some of the subdisciplines identified earlier. A mixed-design analysis of evolutionary behavioral scientists' responses produced again the same pattern of results. It revealed a main effect of typicality (F(1, 30) = 4.4, $p = .045$; $\eta^2 = .13$) and fixity (F(1, 30) = 26.0, $p < .001$; $\eta^2 = .46$). Teleology was not significant (F(1, 30) = 2.5, $p = .12$; $\eta^2 = .08$). Figure 8.5 represents these results.

A mixed-design analysis of experimental psychologists' responses produced a similar pattern of results. It revealed a main effect of typicality (F(1, 33) = 19.3, $p < .001$; $\eta^2 = .37$) and fixity (F(1, 33) = 21.6, $p < .001$; $\eta^2 = .40$). The main effect of typicality was qualified by an interaction with fixity (F(1, 33) = 10.6, $p = .003$; $\eta^2 = .24$). Teleology was not significant (F(1, 33) = .13, $p = .72$; $\eta^2 < .01$). Figure 8.6 represents these results.

Evolutionary behavioral scientists gave marginally more positive answers than experimental psychologists to the question, "Does the notion of innateness have any role within your field(s) of research?" (t(64) = 1.98, $p = .052$; Figure 8.7) but both groups were more likely to give a positive answer compared to midpoint (evolutionary behavioral scientists: t(30) = 7.3, $p < .001$; experimental psychologists: t(34) = 2.9, $p = .007$).

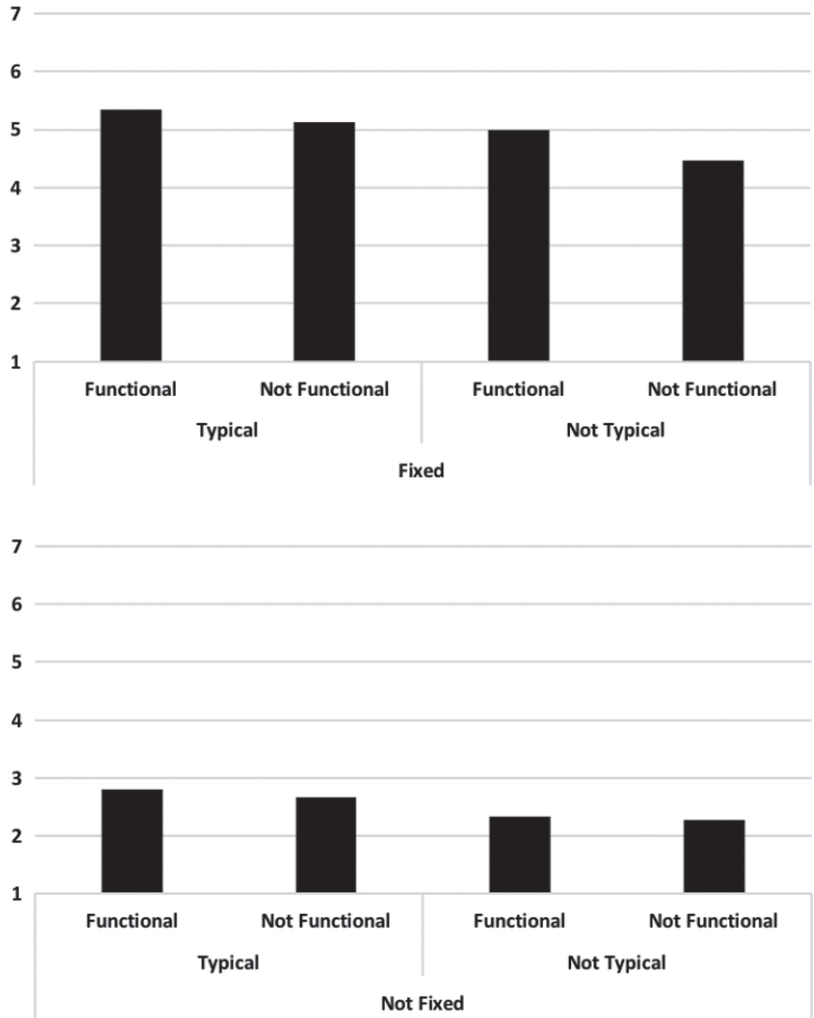

Figure 8.5 Evolutionary behavioral scientists' mean innateness judgments.

A mixed-design analysis of generative linguists' responses produced the usual pattern of results. It revealed a main effect of typicality ($F(1, 20) = 12.4$, $p = .002$; $\eta^2 = .38$) and fixity ($F(1, 10) = 8.8$, $p = .008$; $\eta^2 = .31$). Teleology was not significant ($F(1, 20) = 1.4$, $p = .25$; $\eta^2 = .07$). Figure 8.8 represents these results.

A mixed-design analysis of nongenerative linguists' responses produced a similar pattern of results. It revealed a main effect of typicality ($F(1, 24) = 9.8$,

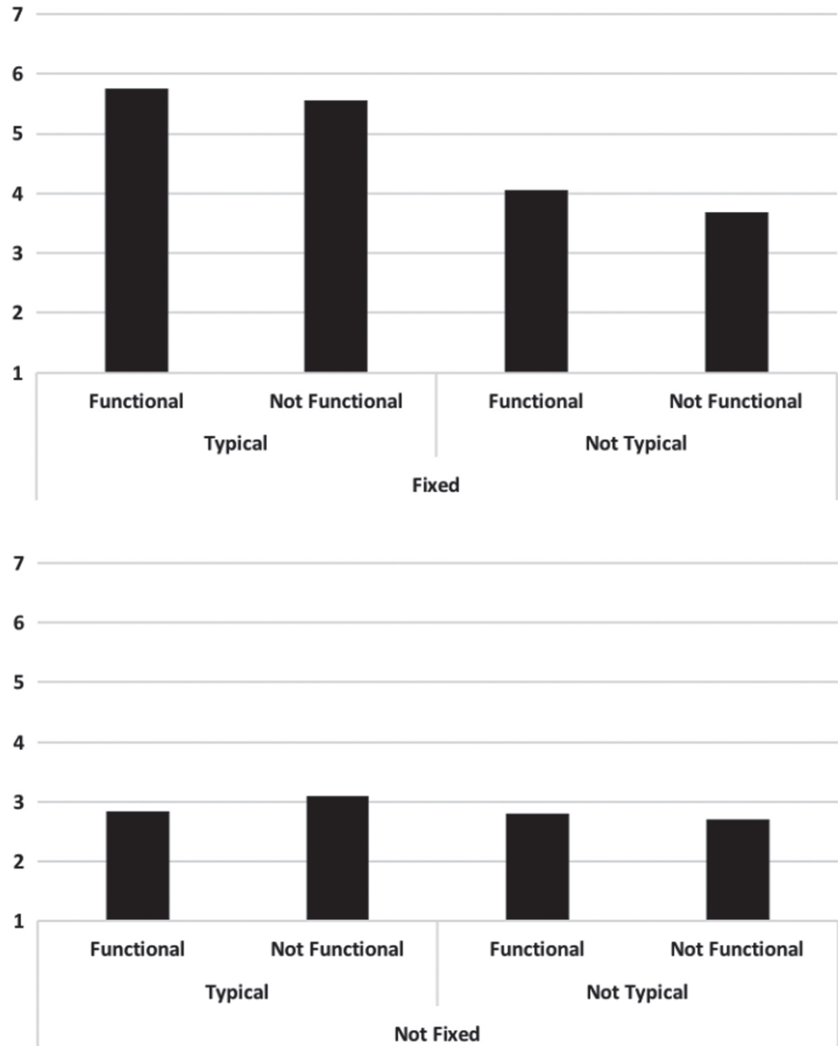

Figure 8.6 Experimental psychologists' mean innateness judgments.

$p = .004$; $\eta^2 = .29$) and fixity ($F(1, 24) = 32.6$, $p < .001$; $\eta^2 = .58$). Teleology was not significant ($F(1, 24) = .74$, $p = .40$; $\eta^2 = .03$). Figure 8.9 represents these results.

Generative linguists gave more positive answers than nongenerative linguists to the question, "Does the notion of innateness have any role within your field(s) of research?" ($t(46) = 3.7$, $p = .001$; Figure 8.10) but both groups were more likely to give a positive answer compared to midpoint (generative linguists: $t(21) = 16.1$, $p < .001$; experimental psychologists: $t(25) = 3.4$, $p = .002$).

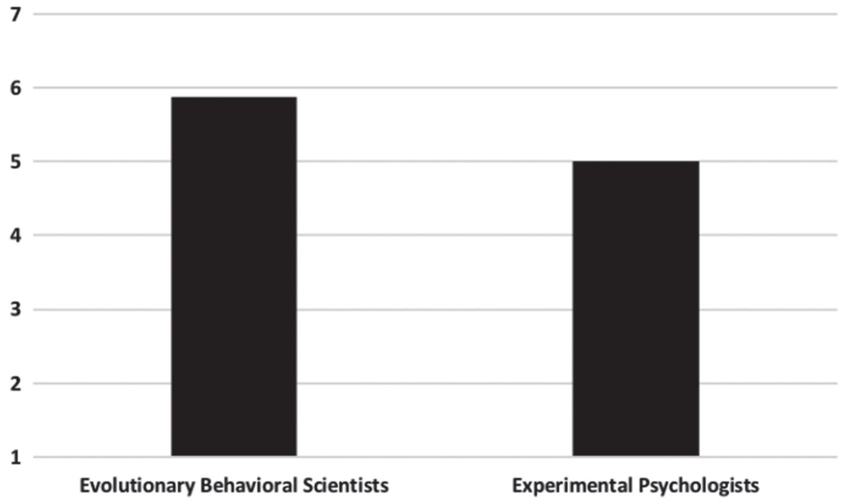

Figure 8.7 Judgments about the importance of innateness among psychologists.

Limitations

Before discussing the significance of the results reported here, it is worth emphasizing their limitations. First, the data were obtained by snowball sampling, and there is no guarantee that our sample is representative of the broader community of linguists, psychologists, and biologists. Second, the sample size is small, particularly when it comes to the subdisciplines we examined. The study is thus low powered, and negative results are difficult to interpret. Third, the classificatory scheme we used was imperfect; participants were allowed to choose several options, and we had to interpret their answers. The rules were developed in advance of analyzing the data, but they were not preregistered and left room for judgment calls. Fourth, our sample is mostly American, raising questions about its generalizability to other countries. For these four reasons mainly, this study of scientists' concepts of innateness remains exploratory. That said, even an exploratory study with such limitations is better than evidence-free speculations about scientists' concepts of innateness.

Discussion

Earlier, we compared two hypotheses about the transformation of a vernacular concept into a scientific concept: the conceptual ecology and the attractor hypotheses. Each hypothesis postulates its own model of the psychological

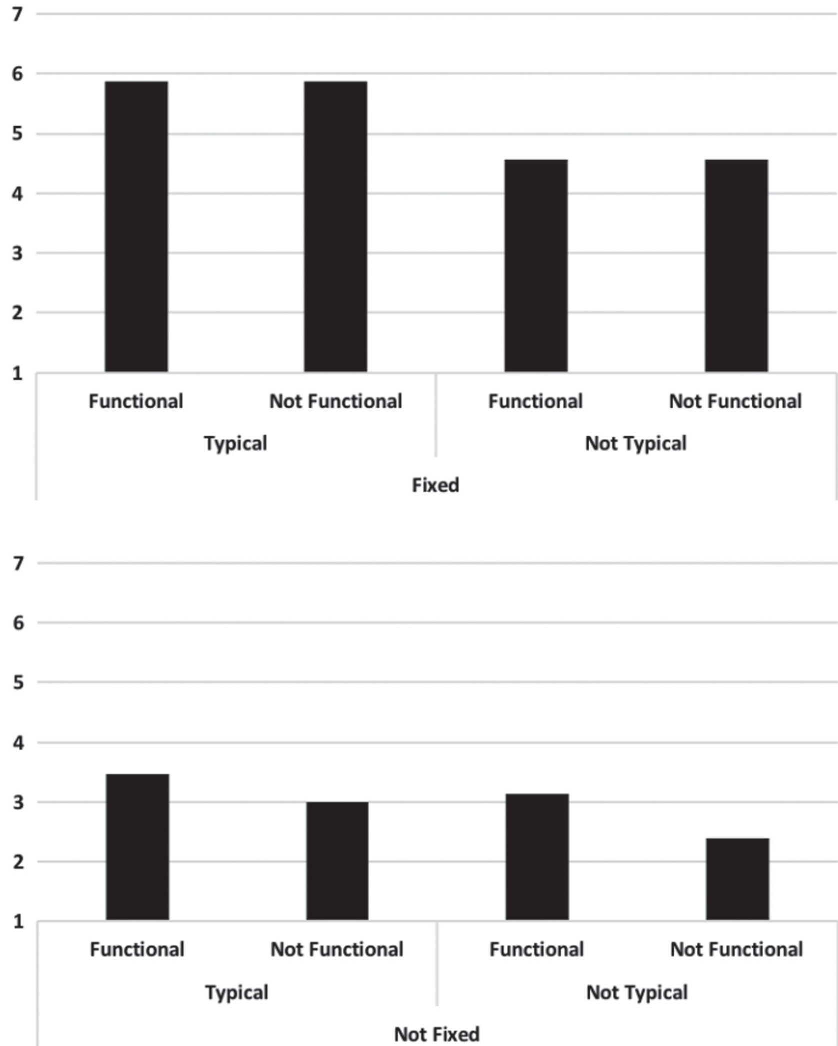

Figure 8.8 Generative linguists' mean innateness judgments.

factors influencing the changes in a concept when it becomes part of scientists' toolkit; it also postulates different trajectories in its transformation into a scientific concept. Most relevant here, they make different predictions about the similarities and differences across scientific communities: The former hypothesis predicts diversity among scientific communities as well as difference with the vernacular concept of innateness, the latter similarity among scientific communities as well as with the vernacular concept of innateness.

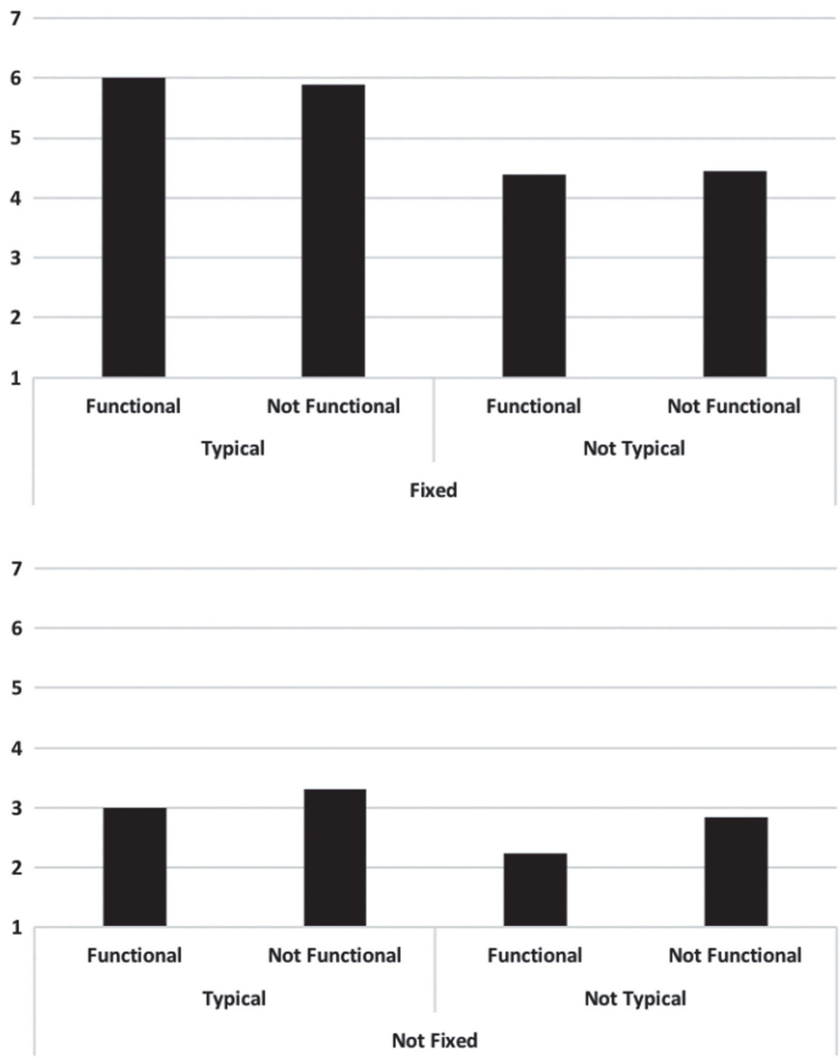

Figure 8.9 Nongenerative linguists' mean innateness judgments.

Our data fit the attractor model much better than the conceptual ecology model. While there may be some small differences across scientific disciplines and between scientists' concept of innateness and the vernacular concept of innateness (more on this below), the similarities are striking. In all the disciplines and subdisciplines we examined, typicality and fixity were important contributors to judgments about innateness, as is the case for laypeople (Griffiths, Machery, and Linquist, 2009; Linquist et al., 2011). Teleology was

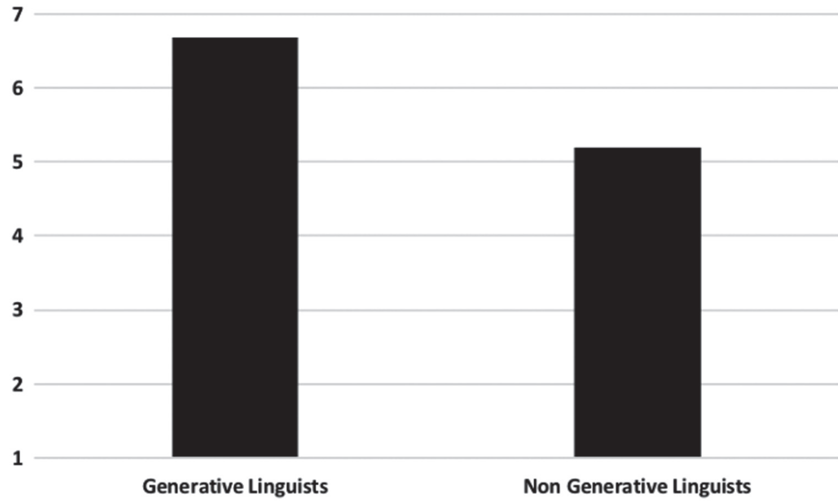

Figure 8.10 Judgments about the importance of innateness among linguists.

not a significant predictor of judgments about innateness; if it predicts them, its influence is small and cannot be detected with the power of our study. This too is in line with our previous results: Griffiths, Machery, and Linquist, (2009) found a small effect of teleology on judgments about innateness, but this effect was not detected by Linquist et al. (2011).

Three results should be highlighted. We didn't find any difference between generative and nongenerative linguists: These two communities sharply disagree about the extent to which language is innate, but they conceive of innateness in a very similar way. Human behavioral scientists did not seem particularly sensitive to the function of a trait when deciding whether it is innate, despite often endorsing an adaptationist perspective on the study of human behavior. Despite the diversity in their training, theoretical knowledge, and explanatory needs, biologists, linguists, and psychologists apparently did not differ in how they conceive of innateness, at least with respect to the probes used in this study.

We did find two small, hard-to-interpret differences. While typicality and fixity are additive factors for laypeople and for most scientists, we found an interaction effect among psychologists who do not embrace an evolutionary perspective on human behavior. Because the effect was small, we refrain from interpreting it. The second difference is between the relative weight of typicality and fixity across disciplines and in comparison to the vernacular concept, as measured by the respective effect sizes. The mixed-factor design is similar to the one followed in Linquist et al. (2011), where we found that fixity and typicality had roughly the same weight for laypeople. Here we find, on the contrary, that fixity is substantially more influential than typicality for evolutionary behavioral scientists, nongenerative linguists~~, and evolutionary behavioral scientists~~. While the greater weight of fixity may be interpretable in light of the conceptual ecology hypothesis, the explanation is not obvious and would be clearly post hoc.

To our surprise, scientists in all the disciplines judged that the concept of innateness was somewhat important in their discipline. One might have expected at least some groups of scientists to dismiss its role in science, but this is not what we found. We found some variation in scientists' opinions about the importance of this concept: biologists judged it less important than psychologists and linguists; among linguists, generative linguists judged it more important than nongenerative linguists; among psychologists, evolutionary behavioral scientists judged it more important than experimental psychologists.

One may think that our results are partly driven by artificial groupings of scientists. For instance, the category of evolutionary behavioral scientists included both evolutionary psychologists and human behavioral ecologists. These two subcommunities may use the concept of innateness differently. The same can be said to different degrees of our other disciplinary groupings. In response, we concede that this is a limitation of our project~~s~~. Had our sample been larger, we would have been able to study more natural groupings. On the other hand, the striking uniformity of answers suggests that this objection is ultimately misguided. Disciplinary affiliation just does not seem to matter.

Scientific and folk concepts

Some concepts have a double life: they help laypeople make sense of their everyday interactions with the world, and they are also used in scientific explanations. The concepts of belief, value, desire, norms, motivations, society, language, weight, heat, temperature, and so on illustrate this situation. What happens to such vernacular concepts whey they are embedded in scientific theories and put to scientific uses? One might think that these concepts get transformed by their local scientific uses, either because scientists intentionally transform them (by, e.g., explicitly proposing new definitions) or merely as a result of repeated uses. This process can be observed in the evolution of the concept of the gene over the past century (Griffiths and Stotz, 2013). The results reported here, however, suggest that this outcome is by no means necessary. Rather than being transformed, particularly in functional ways (so as to fit the conceptual and experimental ecologies of the relevant sciences), the concept of innateness is by and large the same across scientific disciplines, and it is very similar to the vernacular concept of innateness. The vernacular concept of innateness leads scientific thinking to slip into a familiar groove (Machery, 2017b, Chapter 7); it is an attractor that prevents scientists from developing locally useful concepts of innateness.

We do not claim that the attractor model always describes the relation between vernacular concepts and scientific concepts; some concepts may be transformed by scientists in a functional manner. But we do claim that it is sometimes an accurate model. So, what explains why in some situations a vernacular concept functions as an attractor while it doesn't in other situations? As this point, we can merely speculate about two factors. First, concepts like that of the gene are tightly anchored to experimental practices and formal schemes of inference (Griffiths and Stotz, 2013). Their formal character severs their use from folk uses. The situation is obviously entirely different for concepts like the concepts of belief, norm, language, and innateness; no formal structure constrains their use, and vernacular concepts can exert their pull. Second, as we noted earlier, the vernacular concept of innateness has long served as an adequate heuristic, informing various sorts of interaction with the biological world. As we saw, it is part of what psychologists call a lay theory, namely, "folkbiology" (Medin and Atran, 1999). It is not a concept acquired by formal learning, which could be displaced by further formal learning. Such concepts are not replaced by scientific concepts; at best, they coexist with them (Knobe and Samuels, 2013; Shtulman, 2017), and they may influence scientists' thinking. Third, while scientists use the concept of innateness often, it may not be explanatorily central to the disciplines under examination. Most of the experiments scientists run and the specific hypotheses they test may not be much affected were this concept removed from scientists' conceptual toolkit. Scientists may be particularly likely to use such concepts loosely and to let vernacular concepts guide their thinking.

Innateness in science

As was discussed earlier, philosophers of biology and psychology have made various claims about how scientists conceive of innateness (for review, see Gross and Rey, 2012; Mameli and Bateson, 2006). Such claims may be true of scientists' explicit characterizations of innateness; they may capture what we called earlier scientists' *explicit* concepts. But our results suggest that they fail to capture their *effective* concept, the concept they deploy when they are asked to think about innateness. Scientists' effective concept is just the vernacular concept of innateness, and, just like laypeople, scientists are more likely to judge a trait to be innate if its development does not appear to depend on aspects of the environment and if it is shared by many conspecifics.

At this juncture, philosophers of biology and psychology who have proposed analyses of scientists' concepts of innateness may respond as follows. They may concede that in our experiments. scientists deploy the vernacular concept of innateness, but they may insist that this isn't scientists' effective concept. Scientists may not have been particularly careful and attentive. After all, the experimental study was not part of their scientific research and was quite different from the kind of context in which they put their scientific concepts to use. So, they defaulted onto the vernacular concept of innateness.

This concern is reasonable, and it is difficult to exclude the possibility that scientists do have an effective concept of innateness distinct from the vernacular concept but just failed to use it in our experiment. That said, we are skeptical for the following reasons. While the experiment is artificial and obviously different from the research done by our participants, it is not unrelated. All the cases describe real situations; they are not fictional; and the terminology we used is technical. Further, their topic—birdsong—is also commonly discussed in the debates about innateness in developmental psychology (e.g., Gallistel et al., 1991), comparative psychology (e.g., Marler and Slabbekoorn, 2004), and linguistics (e.g., Bolhuis, Okanoya, and Scharff, 2010). So, scientists are somewhat accustomed to thinking about the innateness of birdsong in a scientific context, and one would expect them to draw upon their distinctively scientific concepts of innateness to do so, if they had any.

Let's suppose now that we are right that scientists have not developed scientifically sound technical concepts of innateness, as some philosophers have argued, but rather rely on the vernacular concept of innateness. What is the significance of this fact? As we outlined earlier, the crucial point is that this concept results in inferences that are likely to lead from a true premise to a false conclusion. No trait is fully fixed (Griffiths and Machery, 2008), but the development of some traits is buffered against some specific environmental variation. People who deploy the concept of innateness in their thought would then infer from the fact that a trait seems fixed (i.e., fixed in some respect or other) that it is innate and, from the fact that it is innate, that it is present in most conspecifics (i.e., typical). But this inference is unreliable because these two dimensions, fixity and typicality, are not tightly connected empirically.

Inferring that a trait is typical because it is fixed in some respects will often lead to mistakes. The solution, some philosophers have proposed, is to eliminate the folk notion of innateness (e.g., Griffiths, 2002). But now if scientists do in fact use the vernacular concept of innateness rather than distinct, sound concepts of innateness, then the use of the concept of innateness should also be eliminated from science.

Perhaps a critic will respond that instead of eliminating the concept of innateness, philosophers and scientists should develop a sound concept of innateness; currently, scientists do not use scientific concepts of innateness, but they surely could, and developing such concepts is what should be done. We do not want to dismiss this argument too promptly, since some of us have said similar things for the concept of human nature (Griffiths, 2012; Stotz and Griffiths, 2018; Machery, 2017a, 2018), but we believe that the attraction which the vernacular concept of innateness seems to have on scientific thinking should lead us in another direction: better eliminate than develop new concepts and then fall back on the vernacular concept.

Conclusion

We have reported an exploratory study of the concept of innateness among scientists. Drawing on our past work on the vernacular concept, we have provided evidence that scientists' effective concept of innateness (in contrast to their explicit concept) is invariant across disciplines and is similar to the vernacular concept of innateness. This finding suggests that, at least in the case of innateness, the integration of a folk concept into a scientific conceptual toolkit does not lead to the formation of several distinct, scientifically sound concepts of innateness that fit particular theoretical and experimental niches; rather, the vernacular concept constrains the way scientists think about innateness. This finding reinforces the argument repeatedly made in recent decades that the concept of innateness should be eliminated.

Notes

1 By *concept* we simply mean the cognitive structure that is used in categorization judgments and that is somehow associated with the relevant word. So, the concept of innateness is the cognitive structure that is used in the judgments that something

is or is not innate and that is somehow associated with the word *innate*. There is no need for present purposes to specify the notion of concept more precisely, but one way to do so would be to follow Machery, 2009 and 2017b, Chapter 7. We will also at times refer to what scientists mean by a given word or to scientists' understanding of something to refer to the same cognitive structure.

2 We will usually drop *effective* in what follows. When we refer to scientists' concept of innateness, we have in mind their effective concept.

3 We are not committed to the view that the concept of innateness is a prototype, just that it represents prototypical features.

4 Because only a few individuals were classified in this post hoc manner, nothing substantial hangs on these decisions.

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