



Epistemic niche construction and non-epistemic values: the case of 19th century craniology

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Abstract

In this paper, we will focus on a specific way in which non-epistemic values can influence scientific inquiry, i.e., how they affect the way in which members of a scientific community apply epistemic values. We will first introduce the concept of epistemic niche construction in science, that is, the idea that the epistemic commitments underlying the practice of a scientific community result from a feedback-loop process between the scientific practice itself and the related disciplinary matrix. We will then describe how non-epistemic values can affect the different steps of this feedback-loop process. We will substantiate our argumentation through a historical case study: the rise and fall of nineteenth-century craniology.

Keywords Epistemic niche construction · Non-epistemic values · Epistemic values · Craniology · Scientific practice

1 Introduction

According to Tolstoy, all happy families are alike, while each unhappy family is unhappy in its own way. Perhaps the “Anna Karenina principle” holds also for science. While paradigmatic examples of good science might seem all alike, each case of problematic science has something unique to it. There are many ways in which scientific practice can go wrong. This paper focuses on one of these ways, namely, how non-epistemic values can be considered to illegitimately affect the application of epistemic values in scientific practice.

To exactly pinpoint this illegitimate influence, we will first need a fine-grained account of how some epistemic commitments, such as the specific application of epistemic values practiced in a scientific community, can arise. We will do this by virtue

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of an analogy with the biological domain. Specifically, we will introduce the concept of epistemic niche construction, i.e., the idea that the epistemic commitments in the practice of a scientific community result from a feedback-loop process between the scientific practice itself and the related disciplinary matrix. This feedback-loop process is structurally analogous to the one between the environment and organisms in biological niche construction. We will then describe two ways in which non-epistemic values can affect this process of epistemic niche construction, respectively influencing different steps of the feedback loop between a scientific practice and the related disciplinary matrix. We will substantiate our picture with the help of a historical case study, that is, the rise and fall of nineteenth-century craniology. Specifically, we will see that two non-epistemic values, namely, kind essentialism and hierarchical ordering, crucially constrained how epistemic values were applied by the craniological community.

Our aim in this paper will be three-fold. First, we will show the subtle influence that non-epistemic values exerted on craniology as a scientific inquiry. Secondly, we will demonstrate the usefulness of the concept of epistemic niche construction for analyzing neglected epistemic dynamics in science, such as the emergence of certain epistemic commitments in the practice of a given scientific community. Thirdly, our analysis will provide further evidence that non-epistemic values can influence scientific practice and its epistemic values in many different, contextual ways.

In Section 2, we will present our general picture of epistemic niche construction in science. In Section 3, we will de-idealize our picture of epistemic niche construction, by describing how non-epistemic values can affect this epistemic process. Section 4 will be dedicated to our case study, namely, the rise and fall of nineteenth-century craniology. Section 5 presents the philosophical conclusions of our analysis.

2 Epistemic niche construction in science

In this section, we will introduce the central concept of this paper, namely, the idea of epistemic niche construction in science. More specifically, we will, first, in Section 2.1, briefly survey how the concept of niche construction has been used in scientific and philosophical literature. Then, in Section 2.2, we will present our picture of epistemic niche construction in science.

2.1 Niche construction across science and philosophy

The concept of niche construction originated in the biological domain, specifically in evolutionary theory.¹ In evolutionary theory, niche construction is a process by which organisms through their metabolisms, their activities, and their choices modify their own and/or others' niches (Odling-Smee et al., 2003).² The phenomenon of niche

¹ Note that the concept of niche, as such, is central to other subfields of biology beyond evolutionary theory. For example, the concept of niche is foundational to the discipline of ecology, in which it is defined in a different way (cf. Trappes, 2021). We focus here on the evolutionary concept of niche construction.

² For the purposes of our paper, we focus on the general idea of niche construction, as popularized by Odling-Smee et al. (2003). This general idea has been further developed in more recent works (cf. Laland et al. 2016, 2017; Aaby & Ramsey, 2019; Chiu, 2019).

construction is at the center of niche-construction theory, an extension or modification of evolutionary theory that conceptualizes niche construction as a second evolutionary process, in addition to (and in interaction with) natural selection.³

The main difference between niche-construction theory and the classic neo-Darwinian framework is the active role that organisms, thanks to the process of niche construction, can exert on their environment. If, in fact, in the classic neo-Darwinian framework, the only way through which organisms can fit the environment is to evolve adaptations, in niche-construction theory organisms can fit the environment also by enacting behaviors that transform the environment.⁴ That is, they can engage in niche-constructing activities. These niche-constructing activities emerge as responses to environmental selective pressures, but, by modifying the environment, they contribute to changing those selective pressures. Therefore, while the environment exerts a direct selective pressure on organisms, organisms, via their niche-constructing activities, indirectly modify the selective pressure (Fig. 1).

This modification of the selective pressures determined by niche-constructing activities, in turn, prompts further adaptive responses from the organisms that affect their fitness, thus generating looping effects that are at the basis of the co-creation of the selective environment of certain species (cf. Odling-Smee, 2003). As a result of the process of niche construction, members of many species inherit the cumulative environmental changes induced by previous generations, which can echo in macro-evolutionary patterns.

In the last two decades, the model of niche construction has been extensively applied to several cultural (e.g., Laland et al., 2000, 2001; Laland & O' Brien, 2011) and cognitive (e.g., Griffiths & Stotz, 2000; Stotz, 2010) processes. Even in philosophy, we can find some application of the concept of niche construction, for example, within the program of an evolutionary theory of knowledge.⁵ Notably, Kuhn, 1990, in his 1990 paper, "The Road Since Structure", inspired by Lewontin's work, drew an analogy between niche-construction processes and scientific development. Kuhn's analogy states that the relationship between scientists and the world in scientific practice is structurally analogous to the way in which organisms and the environment influence each other in niche construction. Kuhn's niche-construction analogy, as well as its underlying original picture of scientific practice as co-constructed by scientists and the world, has recently been reassessed as a central component of a viable Neo-Kuhnian account of scientific knowledge (cf. Wray, 2011; Kuukkanen, 2021; De Benedetto & Luchetti, 2023).

³ Note that we take here niche-construction theorizing as encompassing also earlier works than the classic (Odling-Smee et al., 2003). This includes earlier papers from the same authors, such as Odling-Smee (1988), as well as Lewontin (1978, 1982) who anticipated some lines of research they develop.

⁴ Recent literature discusses different varieties of niche construction. For a taxonomy, see Baedke et al. (2021). Here we discuss only the general idea behind niche construction.

⁵ For different uses of the niche-construction concept in philosophy, see MacLeod and Nersessian (2013, 2017) and Rouse (2023).

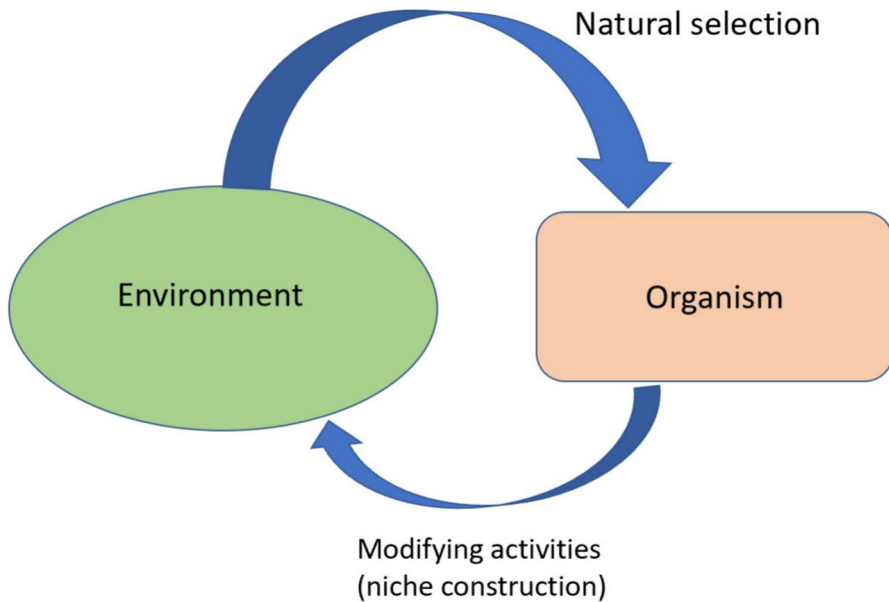


Fig. 1 The feedback-loop dynamic between organism and environment conceptualized by niche-construction theory

2.2 Epistemic niche construction

In this section, we will apply the notion of niche construction to describe a hitherto under-discussed epistemic process in scientific development: the emergence of epistemic commitments in the practice of a scientific community.

First of all, we must clarify that our use of niche construction will be purely analogical, just like the one championed by Kuhn. We take niche-construction theory to be an helpful source of heuristic analogies to characterize neglected epistemic phenomena in science dynamics.

Before introducing our picture, let us define the two central concepts that we adopt: scientific practice and disciplinary matrix. We take a *scientific practice* to be a set of epistemic activities that a given scientific community, at a given point in time, carries out to achieve certain epistemic goals.⁶ Together with the relevant epistemic activities, we assume that a given scientific practice includes also several commitments presupposed by a scientific community to carry out its activities. These commitments include perceptual, cognitive, pragmatic, and, crucially for us, epistemic commitments. Epistemic commitments of a scientific practice might include, for instance, basic assumptions on scientific justification, standards of evidence evaluation, basic norms of beliefs, and how to apply and weigh epistemic values (e.g., empirical adequacy,

⁶ Here we draw inspiration from Chang (2011, 2014) account of scientific practice. We do not claim to be entirely faithful to Chang's elaborate conceptualization of a system of practice, but we simply adopt its intuitive description of the concept of scientific practice.

simplicity, etc.). The second central concept in our picture is *disciplinary matrix*, i.e., the methodological framework related to a given scientific community. More exactly, we take the disciplinary matrix to consist of the set of symbolic generalizations, methodological assumptions, epistemic values, and exemplars that the members of the community explicitly share.⁷ The elements contained in a disciplinary matrix can, but do not need to, be institutionalized as proper epistemic and methodological requirements of an actual, independent scientific discipline.

We conceptualize the disciplinary matrix of a given scientific community as containing the most explicit epistemic elements shared by the members of the community, such as the laws and models routinely employed by the scientists, the measurement standards and techniques accepted by the community, the epistemic values explicitly recognized as criteria of evaluation, and all the exemplar solutions to relevant scientific problems. The scientific practice, on the other hand, contains epistemic commitments that are, for the most part, implicitly assumed by a scientific community in its epistemic activities, such as the evidential standards according to which the community implicitly accepts data as valid, good norms of beliefs and justification commonly presupposed in the everyday dialectic of the community, and the specific way in which the epistemic values of the matrix are weighted and applied in the decisions of the community.

The distinction between scientific practice and disciplinary matrix might, *prima facie*, appear quite arbitrary. Indeed, an analogous problem of individuation affects biological niche construction as well. Some niche-construction theorists express discomfort drawing boundaries between organism and the environment (e.g., Sultan, 2015). Yet, without drawing such boundaries, it is not possible to individuate relevant biological units (see Baedke et al., 2021). Therefore, while there remains a certain degree of choice on how to draw the relevant boundaries, and thus how to identify the relevant biological units, drawing boundaries is necessary to capture important causal influences among the different units. Analogously, while acknowledging that our niche-construction analogy could be developed by adopting other units of analysis, we will build our picture by showing how the differences among our two units result from reciprocal causal influences over time.

The core idea of our picture of epistemic niche construction in science is that the relationship between the scientific practice of a given scientific community and the related disciplinary matrix is structurally analogous to the one between the environment and an organism in niche construction. More specifically, we hold that part of a scientific practice of a scientific community plays an analogous role to the selective environment in niche construction, in that it is co-constructed by a feedback-loop dynamic fundamentally analogous to the one between organisms and environment in niche-construction theory. Recall that the process of niche construction, as described by niche-construction theorists, is structured around the following feedback-loop dynamic. The environment exerts selective pressures on organisms, which, in turn, evolve adaptations, including behaviors through which they can modify the environ-

⁷ Note that the term ‘disciplinary matrix’ was used by Kuhn, for a certain period of his life, to disambiguate the term ‘paradigm’ (see Kuhn, 1974). We use this term in the technical sense defined in the text as encompassing the most explicit assumptions shared by members of a given scientific community.

ment (i.e., the niche-constructing activities). In this way, some products of natural selection feed back into the environment, contributing to the construction of an evolutionary niche. A structurally analogous feedback-loop dynamic, we contend, is at work in (what we call) the process of epistemic niche construction in science. This feedback-loop dynamic can be schematically presented as follows:

1. A scientific practice, via its practitioners, selects a given disciplinary matrix (\approx environment selects organisms).
2. The disciplinary matrix, selected by the practice, includes some explicit methodological and epistemic commitments that modify the epistemic commitments of the scientific practice. In this way, the matrix directly modifies the scientific practice. (\approx organism modifies the environment).
3. As a result, part of the scientific practice of a given scientific community is co-constructed by the practice itself and the disciplinary matrix within which the community operates. Over time, the iteration of this process, produces significant effects (\approx co-construction of the niche).

It is important to stress that, just like in the biological case, this feedback-loop process does not need to follow discrete steps in practice, as the causal selective influences described in our steps can sometime occur at the same time or overlap substantially. Indeed, this articulation in steps serves the purpose of disentangling the causal relationships among units, in our picture as well as in the biological case. As Baedke et al. (2021) discuss for the case of biological niche construction, depictions of loops cannot convey an understanding of how causal processes in and between organisms and environment occur over time. Therefore, the step-wise description helps make explicit the sequential character in which reciprocal causation occurs. To do that, we need to embrace the abstract character of this sequential description.

Let us spell out this feedback-loop process in more details. The first step of this dynamic is taken by the scientific community that adopts the disciplinary matrix within which it operates. By doing that, the scientific practice related to that community, via the medium of the scientific community, selects the matrix.⁸ In turn, this disciplinary matrix modifies the scientific practice of the scientific community that adopted it. More precisely, some epistemic commitments contained in the matrix, such as the lexicon, values, models, and laws accepted by the scientists together with the matrix, produce changes in some epistemic commitments of the practice of the community. For instance, scientists, by choosing to work with certain scientific models and measurement techniques, also accept, even though often only implicitly, some specific background assumption presupposed by the model or technique that, in turn, could produce a modification of their epistemic standards. In this way, while a scientific practice selects a disciplinary matrix, this matrix modifies the practice by shaping and transforming some of its commitments. In this sense, the epistemic commitments of a scientific practice are both preconditions for the adoption of a disciplinary matrix and, at the same time, they are subject to modifications by the matrix. This is analogous to the double status of the selective environment in biological niche construction, which is itself a precondition for the existence of organisms, but is also modified by the

⁸ The selection of the matrix should not be considered as a wholemeal process, but instead as an iterative, piecemeal process.

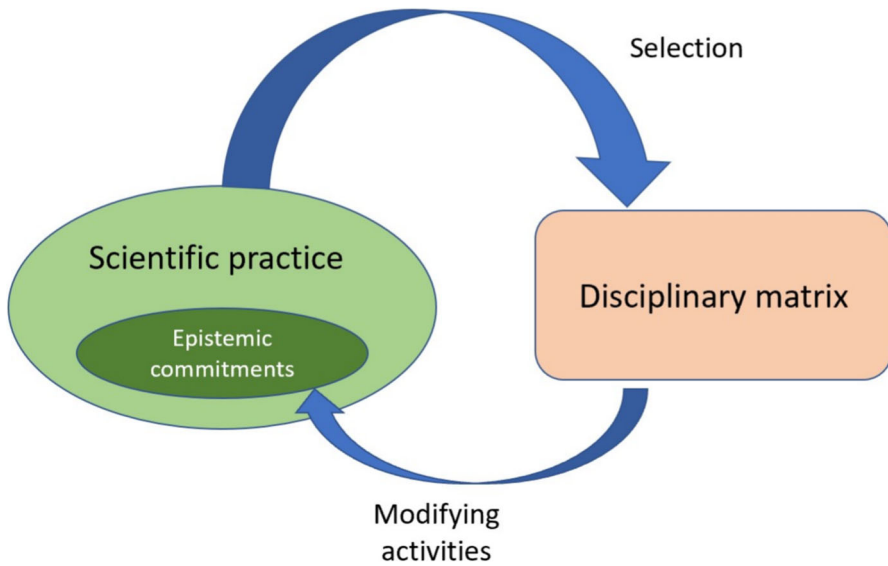


Fig. 2 The feedback-loop dynamic between a scientific practice and its related disciplinary matrix behind the process of epistemic niche construction

organisms' activities. It is through this specific feedback-loop dynamic that part of the scientific practice, just like the selective environment in biological niche construction, is co-constructed, over time, by a scientific practice and a disciplinary matrix (Fig. 2).

This process of epistemic niche construction is an important epistemic process that has been neglected in philosophical theorizing about science. Understanding the epistemic commitments of a given scientific practice as the result of a process of epistemic niche construction allows us to identify the specific epistemic dynamics behind the emergence of certain specific standards and norms of a scientific community. This can be seen, for instance, if we look at one of the central implicit epistemic commitments of a scientific community, namely, the way in which epistemic values are applied in the community's evaluating practices, such as theory choice and data assessment. In the history of science, the application of epistemic values varies a lot from community to community and from discipline to discipline (cf. Kuhn, 1977; Laudan, 1984; McMullin, 1983; Longino, 1990; Sankey, 1995; Solomon, 2001). Often a certain value is understood by most practitioners within a specialized community according to a specific application. Yet, although this phenomenon has been widely recognized by philosophers, few philosophical attempts have been made to describe the epistemic dynamics behind its emergence.⁹

The process of epistemic niche construction gives us a possible conceptualization of this phenomenon. The way in which epistemic values are applied in a community can be seen as resulting, in fact, from the feedback-loop between scientific practice and disciplinary matrix. More specifically, the process can be described as follows. First,

⁹ For a recent perspective on how the weighting and the application of epistemic values in scientific theory choice can emerge, see De Benedetto and Luchetti (2024).

the way in which a scientific community implicitly applies epistemic values in their epistemic activities contributes to the selection of the disciplinary matrix, that is, the set of epistemic and methodological commitments explicitly shared by the community. Second, the adoption of a disciplinary matrix produces changes in the epistemic commitments involved by the practice related to the disciplinary matrix, including the way in which epistemic values are applied to carry out the epistemic activities of the community (e.g., theory choice, data assessment). Thirdly, these changes in the application of values can, in turn, produce effects that feed back into the process of selecting a new disciplinary matrix or some of the epistemic commitments of the existing matrix. Over time, through this feedback-loop process, a specific way of applying epistemic values becomes crystallized in the practice of a given community.

3 Non-epistemic values and epistemic niche construction

We saw how our picture of epistemic niche construction in science conceptualizes the epistemic commitments of a given scientific practice, such as the specific application of epistemic values, as co-constructed by the practice itself and the related disciplinary matrix.

In this section, we will apply this idea of epistemic niche construction to the relationship between epistemic and non-epistemic values. More exactly, we will de-idealize our picture of epistemic niche construction to see which role non-epistemic values can play in this process. We will see that non-epistemic values can influence the process of epistemic niche construction in at least two different ways, affecting different steps of the feedback-loop dynamic between a scientific practice and the related disciplinary matrix. In the next subsection, we will briefly survey the philosophical literature on epistemic and non-epistemic values, while, in Section 3.2, we will see how non-epistemic values interact with the process of epistemic niche construction.

3.1 Epistemic and non-epistemic values

Following a well-established terminological choice, we call epistemic values the values that promote the epistemic aims of science, such as truth, knowledge, or understanding. Standard examples of epistemic values include empirical adequacy, internal consistency, simplicity, scope, and accuracy (cf. Kuhn, 1977; McMullin, 1983). These values are traditionally considered to be epistemic as they are believed to be indicators of the truth (or at least of the truth-likeness) of a scientific theory or, more generally, of its epistemic goodness (cf. Douglas, 2021; Elliott, 2022).¹⁰ Following (Kuhn, 1977; 1983), we take the set of epistemic values to be stable enough over time to identify them across scientific disciplines and traditions. However, as we highlighted when presenting our picture of epistemic niche construction, we claim that their weight

¹⁰ It should be noted that some authors, notably (Douglas, 2009, 2021), further distinguish between epistemic values, understood as values that are indicative of the present epistemic goodness of a theory, and cognitive values, i.e., the values that are indicative of the future epistemic goodness of a scientific theory. We blur the difference between cognitive and epistemic values here, taking the two terms as synonymous.

and application often change depending on the specific scientific community under focus. We call instead non-epistemic values all the other values that are not epistemic, in that they are not reliable indicators of the epistemic goodness of a theory. Standard examples of non-epistemic values include social, aesthetic, religious, cultural, and ethical values, such as freedom, democracy, honesty, beauty, responsibility, and equality. We take the distinction between epistemic and non-epistemic values as a useful pragmatic tool to disentangle different sources of normative evaluation within a certain scientific context, without committing to a realist absolute understanding of this distinction.¹¹ As we will see in detail in our case study in the next section, the main lesson that we will draw from our historical reconstruction of nineteenth-century craniology is that epistemic and non-epistemic values are often closely interrelated in the epistemic judgments of working scientists. Nevertheless, this pragmatic distinction between epistemic and non-epistemic values will prove to be very useful to disentangle the different ways in which values influenced the scientific practice of craniology.

Until the end of the twentieth century, most philosophers of science have generally focused only on epistemic values (e.g., Kuhn, 1977; McMullin, 1983). Values like empirical adequacy and accuracy were, in fact, the only values that should figure in philosophical accounts of scientific reasoning and science dynamics. Behind this restriction lay the so-called value-free ideal, according to which ideal scientific practice should be free from all non-epistemic values (see Lacey, 1999). In the last decades, many philosophers have criticized the value-free ideal on different grounds (cf. Rudner, 1953; Harding, 1986; Longino, 1990; Douglas, 2009). Several important aspects of scientific practices have been argued to necessarily involve non-epistemic values. These allegedly value-laden aspects encompass almost every part of scientific practice, such as the choice of which research topic to study (Büter, 2015; Jukola, 2021), what methodology to use in a given experiment (Longino, 1990, 1995), how to assess different scientific models (Elliott & McKaughan, 2014), or how to deal with uncertain evidence (Douglas, 2000). This wave of philosophical studies on value-laden aspects of science led many philosophers to abandon the value-free ideal and search for new ideals of good scientific practice.

A particularly pressing question for the advocates of value-laden science concerns the legitimacy of non-epistemic values in science (see Holman & Wilholt, 2022). If, in fact, non-epistemic values inevitably affect much of scientific practice, when is this influence legitimate? Several answers to this question have been proposed in recent philosophical literature. The legitimacy of non-epistemic values in science has been argued to depend on the role that these values play (Douglas, 2009, 2021; Steel & Whyte, 2012; Steel, 2015), on their nature (Kitcher, 2001; Kourany, 2010; Brown, 2020), on the systemic practices in which they are embedded (Longino, 1990; Solomon, 2001), or on the norms that govern them (Elliott, 2017, 2022).

Two influential conditions of legitimacy for non-epistemic values in science are (Douglas, 2009) indirect role condition and (Steel, 2015) values-in-science standard.¹²

¹¹ This pragmatic understanding of the distinction is compatible even with critical perspectives of a sharp distinction between epistemic and non-epistemic values (e.g., Rooney, 1992; Longino, 1996).

¹² We focus here on these two accounts because they are highly influential and will serve our purpose to situate the role that non-epistemic values can play in the process of epistemic niche construction. While

Douglas' *indirect role condition* is based upon a distinction between two roles that values can play in scientific reasoning: a direct and an indirect role. Values play a direct role when they "act as reasons in themselves to accept a claim, providing a direct motivation for the adoption of a theory" (Douglas, 2009, p. 96). Values play, instead, an indirect role when they "act to weigh the importance of uncertainty about the claim, helping to decide what should count as sufficient evidence for the claim" (Douglas, 2009, p. 96). According to Douglas (2009), values are always allowed to play an indirect role in science, but never a direct role. This is because, were they allowed to play a direct role, non-epistemic values could make science steer from its epistemic aim of truth. Steel's *values-in-science standard* is based, instead, upon the idea that the role of non-epistemic values in science should always be somewhat ancillary to the role of epistemic values. Specifically, non-epistemic values "should not conflict with epistemic values in the design or interpretation of scientific research that is practically feasible and ethically permissible" (Steel, 2015, p. 178). Thus, according to Steel, granted ethical permissibility and practical feasibility of a given body of scientific research, non-epistemic values are allowed to influence scientific inquiry as long as they do not override the influence of epistemic values.

Both these conditions of legitimacy are motivated by the intuitive idea that non-epistemic values can play a legitimate role in science so long as they do not conflict with its epistemic aims. In famous cases of "bad science", such as the tobacco-sponsored research on lung cancer (Oreskes & Conway, 2011) or the Lysenko affair (Joravsky, 1970), non-epistemic values have clearly overridden scientific evidence and epistemic values, thus directly conflicting with the epistemic goals of science. Yet, as we will show in our case study in Section 4, the influence of non-epistemic values on the epistemic aims of science can be far more subtle and, yet, equally illegitimate. Before our case study, we need to first go back to our picture of epistemic niche construction in science, and see where non-epistemic values fit in it.

3.2 The relations between epistemic niche construction and non-epistemic values

As we have described in Section 2.2, the epistemic commitments of a given scientific practice are the result of a feedback-loop process between the practice itself and the related disciplinary matrix. An example of an epistemic commitment thus produced is the specific application of epistemic values that members of the related scientific community routinely apply in their trade.

It is important to highlight a significant idealization of this picture, namely, that it focuses only on the epistemic commitments of a given scientific community and the changes they undergo. Although the process of epistemic niche construction, as we defined it, is a purely epistemically-driven process, non-epistemic values can significantly affect this process, as we will see in detail in the case study in Section 4.

In order to understand how non-epistemic values can affect the process of epistemic niche construction, we must first identify the place of these values in our picture. We

analyzing the nature, norms, and practices related to non-epistemic values from the perspective of epistemic niche construction could be indeed a worthwhile project, we restrict ourselves here to analyze the role of these values, leaving the rest for future work.

consider non-epistemic values as a part of the set of commitments that members of a scientific community have, independently of their scientific practice. That is, non-epistemic values do not belong to the set of specific commitments required to perform the epistemic activities of a scientific community. Rather, they belong to the broader social, economic, and cultural background that scientists, as members of a historically and geographically situated social context, bring with them in the scientific practice. As such, in our abstract picture, we will represent non-epistemic values as a relatively autonomous group of commitments of a given scientific community.¹³

Although non-epistemic values are not part of the epistemic feedback-loop between a scientific practice and its disciplinary matrix, they can nevertheless interact with it. To see how this interaction plays out, let us go back to our biological analogy. In biological niche construction, external influences can significantly affect the process of niche-construction between an organism and its local environment. This can occur in, at least, two different (but not mutually exclusive) ways. First, events at the global scale, such as major climatic changes, can radically alter the selective pressures that the local environment exerts on organisms. Secondly, similar global environmental modifications can also alter the niche-constructing activities enacted by the organisms, such as foraging or sheltering activities. Analogously, in the epistemic case, we can distinguish at least two ways in which non-epistemic values can influence the process of epistemic niche-construction. A first, more evident way in which non-epistemic values can interact with this epistemic process is by influencing the first step of the loop, namely, the selection of a given disciplinary matrix by a given scientific practice, through the medium of a scientific community (Fig. 3).

In this case, the non-epistemic commitments of the community weigh in the choice to adopt (a given part of) a given matrix rather than another. This is a way of influencing scientific inquiry that has been widely discussed in the philosophical literature on values in science (e.g., Solomon, 2001; Douglas, 2009; Steel, 2015; Elliott, 2017). A second, subtler way in which non-epistemic values can interact with the aforementioned epistemic feedback-loop is, by influencing the second step of the loop, that is, the modification of the epistemic commitments of the scientific practice of the community by the disciplinary matrix (Fig. 4).

In this case, the non-epistemic commitments of the community constrain the specific way in which the methodological commitments of the matrix modify the epistemic commitments underlying the practice of the scientific community. By doing that, they indirectly constrain also the epistemic niche-construction process. This latter kind of influence can be regarded as an example of how non-epistemic commitments encroach into the epistemic commitments of a scientific practice, such as the application of epistemic values. This is a potentially problematic encroachment that has been highlighted by feminist philosophers of science (cf. Rooney, 1992; Longino, 1995). For example, Longino has stressed how social conservative and patriarchal views have sometimes encroached into simplicity-driven judgments in economics (Longino, 1995, p. 393). In the next section, we will show by virtue of a case study, a specific instance of this

¹³ For simplicity, we abstract away here from the inevitable existence of divergencies on commitments to non-epistemic values internal to a community of practitioners. More generally, our representation of non-epistemic values as an autonomous group of commitments is subject to similar idealization and abstract modeling caveats than the one we stressed in Section 2.2.

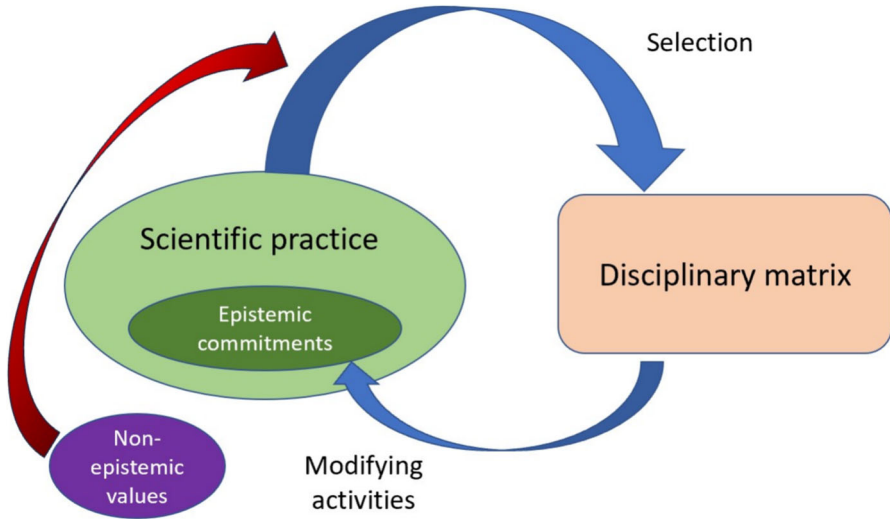


Fig. 3 The first way in which non-epistemic values can affect the process of epistemic niche construction, namely, by influencing how a scientific practice selects the disciplinary matrix

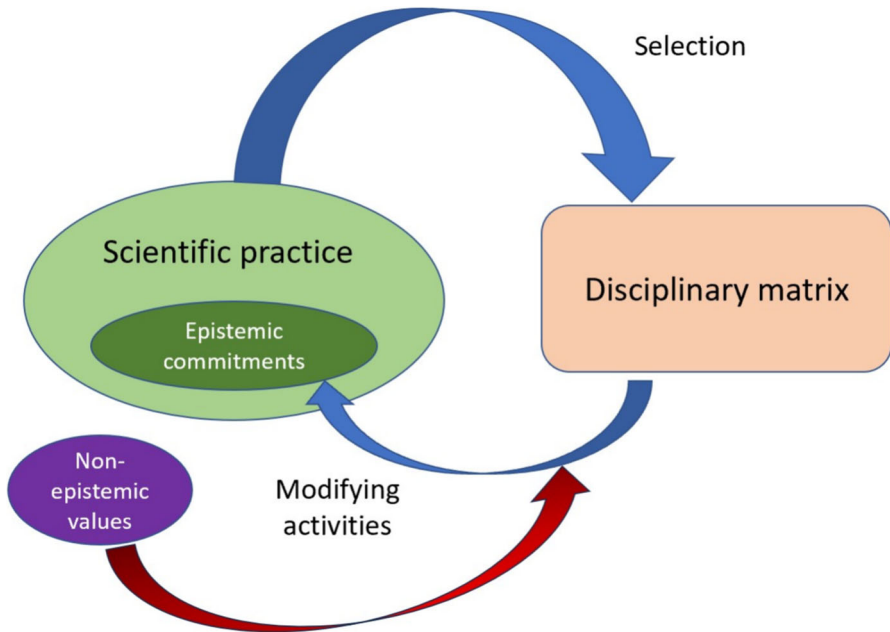


Fig. 4 The second way in which non-epistemic values can affect the process of epistemic niche construction, namely, by influencing how the disciplinary matrix modifies the scientific practice

influence, i.e., a historical episode in which non-epistemic values affected how the disciplinary matrix of a given scientific community modified the epistemic commitments of scientific practice in the process of epistemic niche construction.

4 Case study: epistemic niche construction and non-epistemic values in nineteenth-century craniology

In this section, we will show how certain non-epistemic values affected, in a subtle yet significant way, a historical episode of epistemic niche construction, involving the practice of craniology in the nineteenth century. We will see that the non-epistemic values of kind-essentialism and hierarchical ordering constrained how the developing craniological matrix modified the epistemic commitments of the craniological community. Specifically, we will see that these non-epistemic values influenced how two epistemic values, accuracy and simplicity, were applied by craniologists. These specific epistemic commitments, in turn, crucially contributed to delaying the dismissal of the craniological matrix.

Before we enter into the historical details of our case study, a methodological disclaimer is in order. We will provide a philosophical reconstruction of this case, representing the epistemic dynamics of nineteenth-century craniology with our own analytic categories. Our philosophical reconstruction will necessarily adopt abstraction and idealization in representing complex historical dynamics. This can be seen, for instance, in our specific focus on two epistemic and two non-epistemic values. This focus is a pragmatic choice, since we could have considered more (or less) values, and abstracts from the actual historical use and understanding of these values. However, abstractions such as this one are needed for building our philosophical argument showing how the subtle, yet crucial influence that non-epistemic values had in the epistemic niche construction process of craniology defies common general philosophical norms of legitimacy. In this sense, our reconstruction does not aim to constitute a self-standing historical narrative, but it rather serves as philosophically-reconstructed evidence to intervene on a theoretical debate, namely, the debate over the legitimate role of non-epistemic values in science (see Section 3.2).

Our historical reconstruction of nineteenth-century craniology as an example of epistemic niche construction will be based, mainly, on major existing historical and sociological works on craniology (amongst others, Gould, 1981), together with recent epistemological analyses of craniologists' scientific practice (Kaplan et al., 2015; Luchetti, 2022). Our case study will focus on the period that starts with the emergence of the craniological matrix in the first decades of the nineteenth century and ends with its collapse at the beginning of the twentieth century. While practices based on the measurement of skulls had been pursued as early as at the beginning of the eighteenth century, craniology emerged later as a branch of scientific anthropology, a discipline that aimed at measuring all aspects of the human, both physical and mental. Craniology was the branch of physical anthropology that aimed at establishing whether there are differences in mental capacities among human groups based on certain cranial or brain features. Before the emergence of craniology, in the second half of the eighteenth century, the convergence of different social, historical, and epistemological factors had

led to an increased interest in skull measurement (Vermeulen, 2015; Kornmeier, 2017; Richards, 2018). Most notably, the German anatomist J. F. Blumenbach [1752-1840] - often considered the founder of scientific anthropology - owned a large collection of skulls, which included exemplars from several different geographical areas and historical periods. In 1779-80, Blumenbach proposed a taxonomy of five human races (Caucasian, Mongolian, Ethiopian, American, and Malay) that later became widely influential (Banton, 2007). His skull collection had a central role in his anatomy-based racial classification, since Blumenbach believed that skulls features could reveal the racial types that he identified in his taxonomy. Although Blumenbach's classification was guided mainly by aesthetic ideals (Gould, 1994; Richards, 2018), other skull collectors, naturalists, and anatomists, such as P. Camper [1722-1789], S. Soemmering [1755-1830], E. G. Saint-Hilaire [1772-1844], and G. Cuvier [1769-1832], were already using certain measurable features of the skull as indicators of differences in mental capacity among races or among sexes (Coleman, 1964; Fee, 1979; Blanckaert, 1987; Schiebinger, 1989). In general, at the turn of the eighteenth century there was large disagreement as to which criterion, whether beauty or some mental dispositions, should ground a hierarchy among human kinds based on skull features, and whether a hierarchy could be derived at all (Fabian, 2010; Mensch, 2018). This state of affairs underwent important changes that led to the emergence of craniology as a full-blown disciplinary framework.

Our narrative will be divided in three parts, respectively analyzing three different phases of the history of craniology: the emergence of the craniological matrix (1810-1850), the golden age of craniology (1850-1870), and the collapse of the craniological matrix (1870-1906). Each part will first focus on the history and then examine the role that values played in the interactions between the scientific practice of craniology, its disciplinary matrix, and the relevant non-epistemic values.

4.1 The emergence of the craniological matrix (1810-1850)

In the early nineteenth century, a new doctrine concerning the relationship between skull form, brain, and mental functions emerged, that is, phrenology. Phrenology fostered a materialist view of the mind, which identified the brain as the site of mental and emotional functions and established a correlation between the size of cerebral organs and the power of mental faculties (Erickson, 1977; Kornmeier, 2017; Van Wyhe, 2017). Phrenologists focused mainly on individual differences, rather than group differences. Even though phrenology was popular mainly among non-specialists and it was often discredited in scientific milieus, it had a strong influence on physical anthropologists and comparative anatomists. In particular, the core assumption of a correlation between skull size and strength of mental faculties was shared by authoritative scientists of the time, such as the already-mentioned French naturalist and anatomist Georges Cuvier (see Cuvier, 1817, 1837). This assumption had a central epistemic role in craniological practice as the foundational piece of justification that validated the practice of measuring skulls as a source of quantifiable evidence of differential intellectual abilities across human groups (Luchetti, 2022). A paradigmatic case in this sense was the work of the American physical anthropologist Samuel G. Morton [1799-1851]. Morton owned a

large collection of human skulls, to which he added new exemplars throughout his life and which he used as a basis for his cranial race science (Fabian, 2010; Mitchell, 2018). Morton provided detailed analyses of skulls of various indigenous groups based on multiple thorough measurements of skull features. Even if his specific measurement techniques and samples changed across time, Morton's practice notably included the measurement of the internal capacity of skulls - categorised according to Blumenbach's classification of human races - as a proxy for brain size. Then, he ranked the racial groups according to average cranial capacity, which he implicitly assumed to be the physical indicator of intelligence (Gould, 1981; Richards, 2018).

Morton's work sits at a crucial historical intersection. His methods of cranial measurement rapidly became internationally recognized (Poskett, 2015), and his racial hierarchies of intelligence were widely used as scientific support against anti-slavery movements (Brown, 2015). More generally, the popularity of Morton's work indicates that his craniological practice was a central building block for a national and international community of craniologists that started to explicitly share core epistemological, methodological, and ontological commitments, that is, a disciplinary matrix.¹⁴ A central epistemic commitment of this emerging matrix was the possibility of quantifying group differences in human mental capacities by measuring skull features.

Morton's craniological practice relied on a set of epistemic commitments that proved to be crucial to the emerging scientific practice of craniology. For the purposes of our argument, we will focus on two epistemic values that were central to Morton's measurement practice: accuracy and simplicity.¹⁵ Accuracy was crucial to Morton's practice inasmuch as he strove to standardize his measurement procedures and make them as rigorous as possible, for instance by selecting the optimal material to fill the skulls and, therefore, measure their volume (Gould, 1981; Tuana & Peterson, 1993). Morton describes in extremely detailed manner all the procedural aspects connected with preparing, manipulating, and measuring the skulls in order to obtain as accurate measurements as possible.¹⁶ Simplicity was central to Morton's practice, because, even though his practice involved measuring a multiplicity of skull features, only very few of these features were eventually selected to have meaning, at least as indicators of mental ability (Carson, 1999). That is, a strong operation of selection and abstraction of the skull features was required for Morton's standardized measurement to succeed in providing evidence for inter-group mental differences. Skulls are very messy objects, and the goal of obtaining one single skull-based physical indicator as a source of evidence for intelligence differences responded to a strong epistemic

¹⁴ For historical overviews of the American school of physical anthropology see, for example, Dain (2002), Gossett (1963), Shapiro (1959), and Stanton (1960). On the French school of anthropology, see, for instance, Blanckaert (1989), Kremer-Marietti (1984), Stocking (1964), and (Williams, 1985). For an overview of the German school of anthropology see, for example, Mann and Dumont (1990) and Vermeulen (2015).

¹⁵ As we already stressed, we focus our attention only on these two values to make our philosophical point clearer. Other epistemic values were arguably involved in this emerging matrix, such as precision, replicability, reliability.

¹⁶ See, for instance, the description he provides in *Crania Americana* (1839, especially p. 253 and following).

reductionist tendency, that can be regarded as a specific application of the value of simplicity.

In this respect, Morton's application of these values reveals an understanding of measurement that is restricted to its material and technical aspects. That is, he considered the proper execution of a concrete measurement procedure as, by itself, sufficient to justify the evidential use of the measurement data thereby produced, i.e., for these data to be reliable indicators of the quantity of interest (Luchetti, 2022). More importantly for us, the values of accuracy and simplicity, in these specific applications, became central to the disciplinary matrix emerged with the work of Morton and other craniologists at the time. As we will show in the next subsection, the consolidation of the craniological matrix affected the way in which these epistemic values were applied in the practice of the growing craniological community.

Together with the the emergence of the craniological matrix, and its progressive adoption by the scientific community, we can see a change in the non-epistemic values related to the emerging craniological community. Until the end of the eighteenth century, the socio-cultural values of the Enlightenment, encapsulated in the ideal of the unity of mankind, tended to foreground the graduality of inter-group differences and their environmental causes, rather than their innateness and fixity. Instead, as the scientific community of physical anthropology became more and more established, craniologists increasingly viewed the human species as composed of sharply separate groups that intrinsically differed in natural, moral, and intellectual capacities. Consistently with these views, craniologists increasingly committed themselves to non-epistemic values like kind-essentialism and hierarchical ordering. We take, in this context, *kind-essentialism* as a short-term for sexual and racial kind-essentialism, that is, the commitment to viewing human kinds, such as races and sexes, as sharing a common, intrinsic essence. We take instead *hierarchical ordering* as a short-term to hierarchical ordering of human kinds, i.e., the commitment to viewing human kinds as occupying a specific place into a linearly ordered hierarchy. While these values were not embraced by the totality of craniologists,¹⁷ nor can they be considered necessary to the emergence of craniology as an epistemic practice, the role of these values had an impact in how craniological evidence was generated and used to promote different social and political agendas in different local contexts (cf. Fee, 1979; Gould, 1981; Schiebinger, 1989; Tuana & Peterson, 1993). Importantly for us, these non-epistemic values will play a crucial role in the second part of our narrative. Nevertheless, at this stage of the development of craniology, while these non-epistemic values were central to how craniological claims were interpreted and used to foster social and political agendas, they do not seem to have had a specific role in constraining the meaning and application of the epistemic values central to the emerging matrix. In other words, while these non-epistemic values were increasingly popular among members of the emerging craniological community, the adoption of the craniological matrix was guided by epistemic values and commitments that rather reflected the influence of other natural sciences (e.g., measurement accuracy and simplicity from the physical sciences).

¹⁷ One example is the German craniologist Friederich Tiedemann [1781-1861] who, while fully embracing the disciplinary matrix of craniology and the same racial classification as Morton's, rejected the hierarchical reasoning widespread among 1830s and 40s craniologists.

4.2 The golden age of craniology (1850-1870)

In the second half of the nineteenth century, craniology lived its golden age, enhanced by the increasingly pervasive hereditarian view of differences among human kinds promoted by Darwinism, which strengthened the explicit reliance on cranial measurement for the study of inter-group differences in mental worth (Shields, 1982; Russett, 1991). The community of craniologists further consolidated internationally thanks to figures such as Adolph Retzius [1796-1860] in Sweden, Joseph Barnard Davis [1801-1881] in Great Britain, Carl Vogt [1817-1895] in Switzerland, and the famous French neurologist Paul Broca [1824-1880] and his disciple Paul Topinard [1830-1911].

In this period, craniologists produced an impressive amount of measurements. On the one hand, the accuracy of their material procedures and of their measurement instruments was the central standard that, according to craniologists, would ensure the reliability of craniological data.¹⁸ On the other, the simplicity underlying their search for a single skull-based indicator of intelligence, whether it was cranial capacity or alternative indices, was hardly ever questioned, despite the multiplicity of features considered by craniologists in their practice.¹⁹ While the measurement data produced through their methods are, to our contemporary eyes, entirely inadequate to answer their questions concerning intelligence differences among human groups (Kaplan et al., 2015), this was not the case from within the epistemic standards of their time, given that craniologists lacked most of the biological and statistical knowledge necessary to even realize the inadequacy of those data. Even if they had some statistical sensibility, which suggested them that there would never be a perfect correlation, craniologists were often faced with pieces of evidence that seemed to disconfirm the stereotypical hierarchies of intelligence, such as very large female skulls or particularly small skulls belonging to famous male Caucasian scientists or intellectuals. These problematic data-points were typically explained away by recurring to *ad hoc* assumptions, they were excluded with the excuse that they were produced with unreliable methods, or they were even ignored as statistical outliers of immutable hierarchies of human groups (Fee, 1979; Gould, 1981; Russett, 1991; Tuana & Peterson, 1993).

Most importantly, the reaction of craniologists to these recalcitrant data was to further increase their efforts at standardizing and rigorizing their measurement procedures, or to shift to alternative single parameters that could work as physical proxies for intelligence. In short, they largely relied on the epistemic values of accuracy and simplicity, in the specific application that was becoming central to the scientific practice of craniologists, to reconcile the evidence they produced with their claims. In this sense, we can see the relationship between the scientific practice of craniologists and their disciplinary matrix as a process of epistemic niche construction. More precisely, the success of the craniological matrix contributed to fixing a specific application of the epistemic values of accuracy and simplicity as central implicit epistemic commitments in craniological practice. These epistemic commitments guided the production and assessment of evidence during the whole golden age of craniology. The resistance

¹⁸ See Hoyme (1953) for an excellent overview of craniological measurement instruments and of craniologists' strive to improve their precision.

¹⁹ Cranial indices alternative to cranial volume had already been proposed decades earlier, for instance Camper's facial angle, later refined by Cuvier into a scale (1837).

to disconfirmation of their hierarchies of intelligence could be sustained thanks to this process of epistemic niche construction. This is because the centrality of the epistemic values of accuracy and simplicity, understood *qua* procedural measurement precision and maximal variable reduction, could “bear the burden of trust” against recalcitrant evidence.

Yet, the full story cannot be told in purely epistemic terms. Indeed, the success of the craniological framework, which led to such a fixed application of the values of accuracy and simplicity, was influenced by the non-epistemic commitments of the majority of craniologists. In particular, the values of kind-essentialism and hierarchical ordering were at the foundation of their views about inter-group intelligence differences. More precisely, the interaction between these two values and the process of epistemic niche construction between the scientific practice of craniologists and their disciplinary matrix can be described as follows. As we have seen, in the previous stage, with the emergence of the craniological matrix, certain epistemic values were adopted by the craniological community as conducing to their epistemic goals. At this time, while non-epistemic values were involved in the interpretation and use of the claims of many craniologists, they were not interacting with nor influencing the epistemic values belonging to the matrix. Over time, and with the consolidation of craniology, the matrix started to modify the scientific practice of craniologists. That is, a certain way of applying the core epistemic values, namely, accuracy and simplicity, started to get fixed as an implicit epistemic commitment of craniologists’ scientific practice. It is during this phase that the influence of non-epistemic values significantly affected the process of epistemic niche construction. These values constrained the possible applications of the epistemic values belonging to the craniological matrix. More specifically, the values of kind-essentialism and hierarchical ordering constrained the fixing of accuracy and simplicity according to a specific application.

In particular, the values of kind-essentialism and hierarchical ordering constrained the application of accuracy towards procedural precision of concrete measurement procedures. These two values, in fact, shifted on accuracy the burden of epistemically justifying clear-cut divisions among human groups. That is, they constrained the possible application of accuracy to one that did not put into question the core assumption of fixed different human groups, on which the whole craniological enterprise was based. Questioning this assumptions would have, in fact, revealed the unfeasibility of the craniological project of measuring intelligence differences among human groups through cranial features (cf. Kaplan et al., 2015; Luchetti, 2022). What many craniologists did, instead, was to exacerbate their focus on developing concrete measurement procedures and instruments that could guarantee the accuracy of measurement to which they were desperately clinging. In an analogous way, these two values constrained the application of simplicity in the craniological community towards maximal variable reduction. The majority of craniologists, in fact, in order to preserve the ideal of a single hierarchy of intelligence, searched for a single cranial feature that could serve the purpose of placing all human groups on one scale of intelligence (cf. Carson, 1999). The only possible understanding of simplicity for this community could, therefore, amount to reducing the complexity of cranial measurement to a single variable.

In sum, while these applications of the epistemic values had already emerged in the previous stage, their crystallization was shaped by the influence of non-epistemic

values. By constraining the possible applications of epistemic values, the values of kind-essentialism and hierarchical ordering significantly affected the scientific practice of craniologists. This process of epistemic niche construction provided the craniological matrix with additional and more subtle tools to shield itself from recalcitrant evidence during the golden age of craniology (Fig. 5).

4.3 The collapse of the craniological matrix (1870-1906)

From the early 1870s, craniology entered what (Fee, 1979: 426) calls its “Baroque period”. The progressive increase in the precision of the techniques and in the variety of measurement instruments available to craniologists went hand in hand with the proliferation of new indices and cranial angles that were introduced, with the hope that more measurements would lead to more understanding of intelligence differences among human groups. One consequence of this process was that the disagreement among craniologists concerning several issues - such as the exact number of measurements to take, the best measurement techniques, the most adequate terminology, and the scales and indices to adopt - increased, therefore exposing substantial standardization issues (Buxton, 1933; Morant et al., 1932). More generally, the growing obsession with skull-based quantification of intelligence exacerbated the issues that craniologists had managed to circumvent until that point. While many craniologists were still clinging to the criterion of absolute cranial capacity or brain size well into the

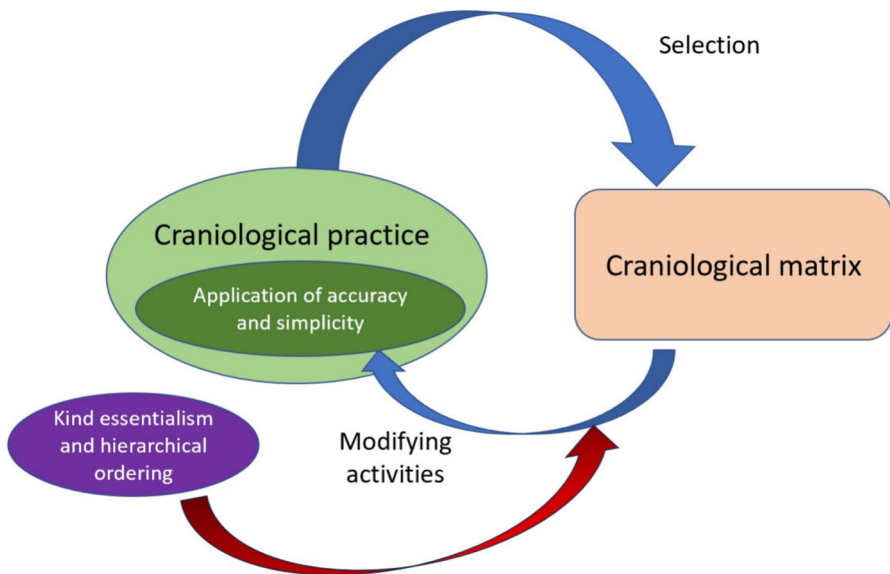


Fig. 5 A depiction of how the values of kind-essentialism and hierarchical ordering affected the process of epistemic niche construction between the scientific practice of craniologists and their disciplinary matrix

1880s,²⁰ the rate of introduction of new cranial indices escalated, under the increasing pressure of producing more accurate and, yet, simple physical indicators of mental capacity. Indeed, measures based on some correlation between brain size or shape and intelligence kept being introduced until the beginnings of the twentieth century, such as Sutherland's measure of the surface area of the brain, introduced in 1900, and Blakemans' index based on the ratio between brain mass and body height in 1905 (cf. Fee, 1979; Tuana and Peterson, 1993). However, these novel parameters were often discarded as quickly as they were introduced, since the absurd consequences deriving from them were more and more manifest to craniologists themselves. It is the case, for example, of the scale based on the ratio between brain size and body weight, one of the most debated alternatives to the criterion of absolute size, despite the fact that it favored women (cf. Russett, 1991). In 1885, Topinard pointed out that, if we take brain size to body weight as a measure of intelligence, a loss of weight would, by definition, correspond to an increase in intelligence, which is obviously absurd.

In sum, the substantial accumulation of disconfirming empirical evidence started to pose serious threats to the core assumption of even an approximate form of statistical correlation between brain size differences and intelligence differences across human groups.²¹ This exacerbated the internal disagreements among craniologists up to the eventual collapse of the craniological matrix. In addition, two external factors further contributed to the demise of craniology. First, an attack against the hereditarian implications of craniology came from those scientists focusing on the plasticity of the brain, most notably, from Franz Boas [1858-1942], a German anthropologist emigrated to the US. Boas forcefully argued against the typological thinking connected to human brains, that is, the fact that craniologists attached fixed or ideal "brain types" to traits such as race and gender to evaluate human intellectual capacity, and he argued for the plasticity of cranial shape and size, and, therefore, mental faculties, with respect to environmental factors such as health and nutrition, against the hereditarian view of physical anthropologists (Stocking, 1974). Secondly, the assumption of a correlation between brain size and intelligence was directly challenged by a group of scientists guided by the English mathematician and founder of the biometrical school Karl Pearson [1857-1932]. Pearson, together with Alice Lee [1858-1939] and Marie Lewenz [1876-1955], showed that the whole craniological enterprise was riddled with statistical issues of a basic kind, including blatant sampling errors, mistakes in the calculations of averages, and the complete neglect of control variables. In 1901, Lee published her first paper, in which she provided evidence against the correlation between skull capacity and intelligence by showing that several skulls belonging to a group of female undergraduates had larger cranial capacity than some male faculty members of the University College, thus offering the choice between accepting evidence of the mental superiority of the untrained female brain or rejecting the correlation altogether. One year later, Pearson (1902) introduced an independent measure

²⁰ Fee (1979) calls this further sub-period the "Neo-Classical" revival of absolute brain size, the last flicker of life before its death in a desperate search for more simplicity.

²¹ For instance, the English physician Henry Havelock Ellis [1859-1939] compiled in 1894 a catalogue of the heaviest brains ever measured, and pointed out that the list included "an imbecile, the Russian novelist Turgenyev, an ordinary workman, a bricklayer, and the French zoologist Cuvier" (cf. Russett, 1991: 36-37).

against which to test for the adequacy of cranial capacity as a measure of intelligence. He compared cranial measurements of a group of undergraduates with their examination test scores, and found no significant correlation. In a further series of papers, Pearson, Lee, and Lewenz provided evidence of the unfoundedness of craniological intelligence indices, including the ratio of body weight to brain size (e.g., Lee et al., 1903; Lewenz & Pearson, 1904). Finally, in 1906, Pearson demonstrated the ultimate failure of craniology in his paper: “on the relationship of intelligence to size and shape of head, and to other physical and mental characters”. While some interest in craniological practices and cephalic indices did outlive these events (e.g. Parsons & Keene, 1919; Coon, 1939), the relevance of craniology as a research program dropped. Furthermore, the emergence of intelligence testing shifted the methodological focus, even if this did not prevent some entrenched background assumptions to migrate in the new science of intelligence (Gould, 1981; Carson, 2007).

In this final stage, we can see how certain epistemic commitments in the scientific practice of craniologists, co-constructed by the practice itself and the related disciplinary matrix, struggled to resist the accumulating amount of evidence against the craniological claims, their hierarchies of intelligence, and the fruitfulness of their measurement practices. Eventually, the epistemic niche between the scientific practice of craniology and the craniological matrix collapsed under the weight of disconfirming evidence.

The collapse of the craniological matrix concludes our analysis of nineteenth century craniology. In this reconstruction, we highlighted the process of epistemic niche construction taking place in nineteenth-century craniology. Specifically, we saw that it was a feedback-loop process between the scientific practice of craniology and the craniological matrix that led to the co-construction of some specific epistemic commitments with which craniologists worked. These commitments, i.e., the fixed application of the epistemic values of accuracy and simplicity, crucially sustained the resistance exhibited by the craniological community to empirical falsification. Yet, we saw that the rise and fall of craniology cannot be told from a purely epistemic point of view. The non-epistemic values of kind-essentialism and hierarchical ordering crucially affected this process of epistemic niche construction by constraining how the epistemic values of accuracy and simplicity were applied in the scientific practice of the craniological community.

5 Conclusion

We presented the rise and fall of craniology as an example of how non-epistemic values can crucially affect the development of a scientific practice. This influence, by itself, did not go unnoticed in the history and sociology of science. Indeed, classic sociological and historical analyses of craniology (e.g., Fee, 1979; Gould, 1981; Russett, 1991; Tuana & Peterson, 1993) have successfully exposed how the non-epistemic values and the socio-political views of craniologists justified instrumental uses of their evidential claims. Most of these narratives also stressed how these non-epistemic values influenced the data they produced through confirmation and measurement biases, based upon racist and sexist views. What our reconstruction introduces is a novel, com-

plementary perspective on the specific role that two non-epistemic values, namely, kind-essentialism and hierarchical ordering, had in this historical episode. Specifically, we showed how these two values crucially constrained the application of the epistemic values of accuracy and simplicity, thus affecting the process of epistemic niche construction. This process, in turn, resulted in the fixation of specific applications of these epistemic values, which crucially shielded the craniological matrix from empirical falsification.

The specific role that non-epistemic values played in our case study is of direct interest for contemporary philosophical debates on non-epistemic values in science. We recalled, in fact, in Section 3.2, two influential legitimacy conditions for the influence of non-epistemic values in scientific practice, i.e., Douglas' indirect role condition and Steel's values-in-science standard. The former condition forbids non-epistemic values to act as direct reasons for accepting a scientific claim, while the latter forbids them to override the influence of epistemic values. Both conditions of legitimacy do not seem to rule out an influence such as the one we saw at work in our case study. The values of kind-essentialism and hierarchical ordering did not, in fact, play a direct role, in Douglas' sense, in the epistemic choices of the craniological community. They also did not conflict with the relevant epistemic values. Nevertheless, these two non-epistemic values clearly had, from our contemporary vantage point, an illegitimate influence. In fact, these two values crucially shaped how the craniological matrix modified the research practice of the craniological community, in that they constrained the possible application of the epistemic values of accuracy and simplicity onto procedural measurement precision and maximal variable reduction. These specific applications of these epistemic values, in turn, made it possible for the craniological community to avoid confrontation with the disconfirming evidence and the internal inconsistencies that threatened the whole craniological enterprise.

Moreover, our case study demonstrates the usefulness of the concept of epistemic niche construction and the diachronic picture of the emergence of the epistemic commitments of a given scientific community that this concept allows. By conceptualizing the epistemic commitments of a scientific community as originating from a feedback-loop process between a scientific practice and its disciplinary matrix, the idea of epistemic niche construction allows us, in fact, to highlight the specific ways in which non-epistemic values can crucially influence these commitments. In this way, the concept of epistemic niche construction can provide a specific mechanism by virtue of which the broader social and cultural context of science can encroach into the epistemic judgments of scientists (cf. Rooney, 1992; Longino, 1995), namely, by constraining the possible applications of epistemic values.

More generally, our analysis dovetails with other recent philosophical contributions (e.g., Büter, 2015; Elliott, 2017; Douglas, 2021) in showing the subtleties of the illegitimate influences that non-epistemic values can exert on scientific practice. As we saw in our case study, even in a paradigmatic case of value-laden science, such as craniological measurement in nineteenth century, the specific way in which non-epistemic values influence scientific practice can be quite hard to pinpoint. As such, the legitimacy of this non-epistemic influence on a given scientific practice seems difficult to box in some general acontextual norm, but seems to require instead a careful

historical and philosophical critical analysis of the epistemic dynamics exhibited by the specific case at issue.

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