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Natural Kinds

Muhammad Ali Khalidi[1]

[1]Graduate Center, City University of New York

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The cognitive achievements of human beings would be inconceivable without the ability to classify the world into categories. In addition to Lassie and Rin Tin Tin, most people recognize "dogs" in general. Along with Andrew and Katrina, some people identify "hurricanes" more broadly. Thus, human beings distinguish not just unique individuals but also *kinds* of things. These kinds can be kinds of concrete objects but also kinds of states, events, processes, and other types of entity. *Natural* kinds are posited to be the real groupings or classes in the world, which we discover through inquiry, distinguish in thought, and label in language. When taxonomic categories are valid and classification schemes are successful, they are said to reveal natural kinds. Calling them natural kinds is an honorific, meant to distinguish them from other arbitrary groups of individuals.

History

The notion of natural kinds seems to presuppose at least a weak form of realism, according to which our concepts and categories aspire to isolate real features of the world. Although discussion of natural kinds has been implicit in many philosophical traditions since ancient times, explicit talk of *natural kinds* can be traced to 19th-century Europe. Philosophers who wanted to distinguish valid classification schemes in the sciences from invalid ones, often spoke of *natural classes* or *natural groups*, and they believed that valid taxonomies would identify *kinds* (Whewell, 1840/1847). The expression *natural kind* was eventually introduced to denote the real groupings revealed by valid classification schemes (Venn, 1889/1907), which is why some philosophers have preferred to call them *real kinds* instead (see e.g., Mill, 1843/1882; Millikan, 2017). This alternative moniker also has the advantage of undermining the widespread assumption that natural kinds are solely the province of the natural sciences, not the social sciences, or that they only pertain to things found in nature, not human artifacts. However, the expression *natural kind* is so entrenched that it is hard to dislodge, so it may be necessary to retain it—but with the caveat that many philosophers have held that there can be natural kinds of social phenomena (e.g., "money," "gender") and artifacts (e.g., "hand axe," "canoe").

In recent years, the term *category* has sometimes been used interchangeably with *kind*. But at other times, it is used to denote the concepts that represent the kinds. To avoid confusion, the term will be used here in the latter sense, to refer to concepts or items in taxonomic or classificatory schemes. With this distinction in mind, it can be said that cognitive scientists are interested both in natural kind categories (the cognitive role of concepts of natural kinds) as well as in the natural kinds themselves (natural kinds in the cognitive domain).

Core concepts

Realism vs. antirealism

Realists maintain that natural kind concepts or categories are central to human cognition precisely because they enable human thinkers to identify real groupings in the world. If these categories are

attuned to real classes of things, as opposed to arbitrary sets, thinkers who use these categories can be expected to reap epistemic dividends when it comes to reasoning about reality. Natural kind categories are thought to be so efficacious because they track actual similarities and differences in the world and ground valid inductive inferences (Quine, 1969; Boyd, 1989; Kornblith, 1995). Categories like "water," "dog," and "hurricane" are more useful than arbitrary classes like "round and green things," "things that make a noise when stepped on," or "things to take from one's home during a fire" (Barsalou, 1983). The former categories can be used to devise generalizations, make predictions, and generate explanations precisely because they correspond to sets or clusters of properties, whereas the latter only correspond to the property that was used to pick them out in the first place. Objects that are both round and green have nothing else in common but that conjunction of properties and include such diverse things as Granny Smith apples, unripe oranges, and some tennis balls. Such categories may play a limited role in our discourse and reasoning, but they are not likely to endure in human cognitive endeavors, and it is not a coincidence that such classes are seldom lexicalized in natural language.

It is possible to deny the existence of natural kinds altogether. *Antirealists* acknowledge that some categories are more efficacious than others and some classification schemes have more cognitive value than others but reject the idea that this is because they correspond to natural kinds (Goodman, 1978; Varzi, 2011). This type of antirealism would then need to explain why some categories and classification schemes are more useful than others, if not because they correspond to reality. It is also possible, especially for researchers primarily interested in categories and concepts rather than kinds themselves, to be agnostic about the existence of natural kinds, focusing instead on the structure of the categories and the role they play in cognition and cognitive development, without regard for their validity or veridicality. But cognitive science is also interested in understanding the relationship of cognizers to their environment, so an attitude of *methodological solipsism* (Fodor, 1980; Stich, 1983), which suspends judgment about the external causes of natural kind concepts, may not be a feasible research strategy.

Pluralism

Some realists claim that natural kinds are *sparse*, or relatively few in number, but other realists are *pluralists*, who hold that there is a plenitude of natural kinds. Indeed, some philosophers think that there may be more natural kinds than human taxonomic categories are able to capture (Dupré, 1993, 2002). This would leave room for variation among individuals, communities, or historical eras in the kinds that they happen to pick out. Some categories may be more salient or useful in some cultural contexts or to some communities than others. Possible variation among categories has sparked interest in the area of ethnobiology and studies of Indigenous knowledge (Atran, 1993) and in comparing folk or Indigenous categories with those of modern science (Ludwig, 2017). This is not to say that all such categories identify natural kinds, because many categories devised by human communities may be of limited epistemic value and have little claim to revealing natural kinds, such as the purported category "women, fire, and dangerous things" (Lakoff, 1987). Categories that group things together that have little or nothing in common do not advance knowledge by facilitating generalization, explanation, or prediction. Moreover,

in scientific discourse, scientists often revise or eliminate categories that are found not to provide the epistemic benefits that they were once thought to do, and categories that might have been instrumental to our ancestors, such as the four "humors" or "hysteria," may no longer be so to modern humans (Quine, 1969). The categories that have played a role in the evolutionary history of our species are not always the ones that figure in the mature sciences. If so, this would give grounds for thinking that categories that are innate (if there are any) or acquired early in development may not have the same status as those of developed scientific research programs.

Natural vs. conventional

Natural kind categories have been contrasted with arbitrary or ad hoc categories, but they are also often contrasted with conventional categories: "gold" is a natural kind, whereas "married person" is a conventional one. However, the problem with considering conventional categories to be the complementary class is that in the human realm, convention can be the basis of valid categories. To illustrate, the distinction between a "married person" and an "unmarried person" in a certain society is based on the conventions surrounding marriage in that society. The basis for the conceptual distinction is also conventional for that very reason. Hence, if social and artifactual classes are considered candidates for natural kinds, the contrasting class should be categories that are arbitrary, or have nothing in common but their defining property. That is why arbitrary groups are also sometimes known as *nominal kinds*, to emphasize that, unlike natural kinds, they are united in name alone. Many conventional social categories are not arbitrary or unified merely by their labels: unmarried men, for example, tend to have different life expectancies, political views, and incarceration rates than married men in many societies. These features and others go well beyond the properties that are used to identify them in the first place.

Essentialism

In some cognitive science research, natural kinds have been associated with *essentialist* doctrines. Essences are properties that are necessary and sufficient for membership in the kind, and they are also often thought to be intrinsic, microstructural, and modally necessary (associated with the kind in every possible world). Some philosophers think that what distinguishes natural kinds is the fact that they have essences or essential properties. The essence of all samples of water is presumably the property of being constituted by molecules that have a specific chemical constitution or microstructure, and the essence of all dogs is thought to be the property of having a certain genotype or a phylogenetic origin (cf. Putnam, 1975; Kripke, 1980). If so, then the categories that correspond to these kinds should also be defined in terms of the necessary and sufficient conditions for membership in these kinds.

However, many philosophers of science have argued that few natural kinds are associated with necessary and sufficient conditions (much less the other features associated with essences). A more plausible account holds that natural kinds share a loose cluster of properties, which may not be singly necessary or jointly sufficient for membership in the kind. Categories that identify kinds are inductively successful because they group individuals that are similar in various respects or share a number of properties but

are not necessarily a requisite set of properties that all and only members of those kinds have. Rather, the properties are widely thought to be associated causally, either by being the effects of a certain causal mechanism (Boyd, 1989; Kornblith, 1995) or by being causally integrated in some other way (Craver, 2009; Khalidi, 2013).

Questions, controversies, and new developments

Natural kinds have featured in cognitive science in two main guises. First, cognitive scientists have been interested in the question of whether categories corresponding to natural kinds play a special role in our cognitive makeup. They ask whether human thinkers possess a dedicated set of concepts that correspond to natural kinds and whether these concepts are innate or acquired. They are also interested in how these concepts are structured and whether they are different from other concepts, as well as whether they play an important developmental role in knowledge acquisition. Second, cognitive scientists have been preoccupied with the question of whether there are real classes in the cognitive domain and if so, what they are. For example, they ask whether *concepts*, *beliefs*, *emotions*, and *cognitive biases* correspond to natural kinds and whether they demarcate real groupings in cognition. These two sets of topics are discussed somewhat separately and by different researchers, though they are not unrelated; because if there are natural kinds in the cognitive domain, it might be expected that they show up in cognition (e.g., concepts of *concept*). This is just what we should anticipate in a science that uses the human cognitive apparatus to study cognition itself.

Concepts of kinds

In the first area of research, cognitive scientists have studied the structure of concepts or categories that correspond to natural kinds, particularly natural kinds in biology, like animals and plants. Some researchers have claimed that the structure of these concepts reflects a commitment to the existence of essences on the part of human thinkers, both children and adults, regardless of whether metaphysical essentialism is true or not (e.g., Keil, 1989; Gelman, 2003). This commitment has been posited to be part of the representation of kinds in general because the disposition to essentializing develops early, the information is rarely explicitly learned, and it is fairly cross-cultural, although different cultures may essentialize different kinds (Gelman, 2003). Other work on natural kind concepts provides evidence that people distinguish principled from accidental properties of a kind and use and interpret generic statements (e.g., “tigers have stripes”) to express generalizations about kinds (Prasada & Dillingham, 2009; Leslie & Gelman, 2012).

However, some have questioned this claim of *psychological essentialism*, arguing that natural kind concepts in children and adults are organized in such a way as to reflect causal structure rather than essences (Strevens, 2000) [see Cognitive Development]. Even some proponents of psychological essentialism allow that the commitment to essentialism that shows up in young children and persists into adulthood is not a full-blown commitment to the metaphysical doctrine of essentialism. Rather, it is just the tendency to think that members of a kind share an underlying nature that may not be perceptually obvious and is

responsible for similarities among members of a kind (Gelman, 2004). The commitment to the existence of kinds, in the sense that there are types of things that share clusters of correlated properties, emerges prior to essentialism (perhaps as early as two years of age) along with attunement to causal patterns (Gopnik & Nazzi, 2003).

There is also evidence that concepts of some of the most paradigmatic natural kinds do not conform to the tenets of psychological essentialism. If the essence of water is believed to be the chemical structure H_2O, then psychological essentialism would predict that thinkers should judge that samples of water are all and only samples of (liquid) H_2O. But some experiments with adults show that their beliefs about the amount of H_2O in a liquid do not correlate neatly with their judgments about whether that liquid is water (Malt, 1994). Some liquids that are believed to be almost entirely composed of H_2O are not considered to be instances of water (e.g., tea, saliva), whereas other liquids that contain much less H_2O (e.g., sewer water, radiator water) are still judged to be water. This and other evidence suggests that concepts of some of the most uncontroversial natural kinds are not structured along purely essentialist lines. When it comes to concepts of chemical natural kinds, people seem to incorporate information not just about chemical composition or microstructural properties but properties such as function, source, and location (Malt, 1994). More recent work argues that the information that is deployed in categorization judgments depends on context and that this can be manipulated in an experimental setting (Tobia et al., 2020).

Other empirical work finds that the structure of concepts of living things is different from that of concepts of artifacts (e.g., "pencil," "chair") or social entities (e.g., "club," "company"; Noyes & Keil, 2020). This is sometimes expressed by saying that natural kind concepts are structured differently from concepts for artifactual or social kinds, where *natural* is understood as pertaining exclusively to the natural world and particularly the biological domain. Unlike categories of animal (e.g., "cow," "raccoon"), artifactual and social categories do not seem to presuppose that entities of the relevant type have an essence in the sense of an underlying intrinsic property that is not directly observable. This research maintains that a belief in kindhood does not imply a belief in essentialism and that people think that kinds are heterogeneous in their causal structures.

However, an established body of work suggests that many social kinds, like "ethnicity" and "class," are also essentialized, at least to some extent or in some ways (Haslam et al., 2000). In addition, this research argues that conceiving of social kinds in this way may be responsible for dehumanizing attitudes toward members of certain social groups. But researchers working in this area have also stressed that there are different strands in essentialism and that these strands are differentially applied to different social groups.

An interesting twist in this debate is that psychological essentialism has been cited as a factor in generating the philosophical doctrine of essentialism. At least some of the arguments in favor of the metaphysical thesis of essentialism in the philosophical literature are supported by thought experiments whose outcome rests on intuitions, and these intuitions have been argued to be a product of psychological essentialism (Leslie, 2013). If so, the reason that some philosophical beliefs regarding natural kinds

embody essentialist principles may not be that these beliefs mirror the world but rather that they are a part of our cognitive makeup, and this realization may play a role in debunking metaphysical essentialism (Neufeld, 2022).

Of course, if people are prone to psychological essentialism but essentialism is not true of the world, it is a challenge to ascertain why there are such essentialist tendencies in the first place. It may be a useful but fallible heuristic that facilitates learning, especially in children (Medin & Ortony, 1989). If essentialism about natural kinds is understood in the weak sense of a tendency to think that members of a kind share a nonobvious underlying nature, then it may be adaptive to harbor such an attitude, at least in some domains (Gelman, 2003). A stronger notion of essentialism concerning kinds may not be psychologically efficacious, but it is doubtful whether essentialism in the strong sense is an entrenched feature of human cognition and its scope is still unclear (e.g., living things, chemical substances, artifacts, social entities).

Cognitive kinds

When it comes to the second guise in which natural kinds have entered cognitive science, namely the natural kinds of cognition itself, the first question to ask is: Are there natural kinds in cognitive science? If we understand natural kinds to be confined to the natural sciences and to be organized according to essentialist principles, then the prospects are bleak. But if not, there is at least an opening for natural cognitive kinds. If so, we can go on to ask which cognitive categories correspond to natural kinds, and which are arbitrary or nominal. One might start with some of the central categories of cognitive science, which may be the most plausible candidates, such as those mentioned earlier: *concepts*, *beliefs*, *emotions*, and *cognitive biases*. These can be supplemented by some of the main headings in standard textbooks, such as "perception," "memory," "learning," "attention," "mental imagery," and so on. These categories, as well as many other central categories in cognitive science, originate (at least in English) in prescientific mentalistic language (Blasi et al., 2022). When it comes to the reality of these categories, much of the groundwork has been laid by philosophers who have asked whether traditional mental categories are suitable to play a role in a scientific psychology or, to put it differently, whether *folk* categories can be expected to correspond to natural kinds. Although some philosophers are skeptical that any such categories are suitable for a science of the mind (e.g., Churchland, 1979), others think that these questions must be decided on a case-by-case basis. And although researchers have cast doubt on some of these categories individually (see, e.g., Machery, 2009, on "concepts," Gomez-Lavin, 2021, on "working memory"), few have cast doubt on all, and indeed, none of these categories have been universally or even widely discredited. The ones that seem most vulnerable are those that have been accused of being overly broad and of lumping together multiple kinds. For example, some have argued that "memory" may not be a natural kind but that "episodic memory" and "semantic memory" may both be (Michaelian, 2011). Similarly, it is possible to deny that the superordinate category "emotion" corresponds to a natural kind but leave open the possibility that categories like "fear" or "sadness" do (cf. Griffiths, 1997).

Another important basis for identifying natural kinds in the cognitive sciences derives from discussions of construct validity in psychology and other sciences. These discussions understand construct validity in terms of how well a test measures a theoretical construct, such as "attention" or "intelligence." One way of relating this to the issue of natural kinds is as follows: Suppose researchers introduce a cognitive construct into scientific theorizing, like "attention" or "intelligence," and a test is proposed to measure it, say a Stroop test or IQ test, respectively. One can then ask whether the test actually measures the construct that it is supposed to measure. Of course, researchers may claim that the test cannot fail to measure the right construct, since that is just how the construct is defined. But critics can charge that there is a circularity here because intelligence has just been defined as whatever it is that the IQ test measures (cf. Francken et al., 2022). So, unless one has some independent handle on intelligence, the construct is vacuous, and the test cannot be said to be valid. Another way of putting this is by saying that one needs to be able to identify the construct as a natural kind, which has a number of other, independent properties that are not measured by the test. Otherwise, one cannot evaluate whether the test measures a valid construct. Some researchers would express this requirement of construct validity in terms of situating the theoretical construct in an interlocking system of laws (*nomological network*), at least some of which involve observables (Cronbach & Meehl, 1955). If one understands laws in causal terms, this seems consistent with the characterization of kinds already given in terms of causal structure. Therefore, the search for valid constructs and the pursuit of real or natural kinds can be seen as two sides of the same coin.

Finally, questions about natural kinds have fueled a surge of interest in questions of so-called cognitive ontology [see Cognitive Ontology]. Much of this can be understood as a concern with the attempt to relate the natural kinds of cognition to those of neuroscience (McCaffrey & Wright, 2022). Neuroscientists seeking to find neural correlates of cognitive constructs have an obvious interest in knowing what the valid cognitive constructs are in the first place (Poldrack & Yarkoni, 2016). If current cognitive categories are not valid, then there would be no point in seeking neural correlates for them. Although some researchers take seriously the possibility of revising the current cognitive ontology used in psychology so that it is integrated with that of neuroscience (Price & Friston, 2005), others anticipate a direct *structure-to-function mapping* that reduces psychological constructs to neural ones (Bickle, 2003).

A straightforward structure-to-function mapping is complicated by the phenomena of multiple realization and pluripotency. Multiple realization obtains when the same psychological functions are realized or implemented by different neural structures (Aizawa & Gillett, 2009) [see Multiple Realizability]. Meanwhile, pluripotency or *neural reuse* occurs when the very same brain regions or networks are involved in a multiplicity of distinct psychological functions (Anderson, 2014). Consequently, some researchers have proposed context-sensitive mappings that would take into account the wider neural context, not just the regions of interest for a given function (Klein, 2012; Burnston, 2016). Others argue that there will not be neat matchups between psychological and neural constructs at all, especially since psychological constructs are individuated relative to a broader extra-neural context (Francken & Slors,

2014; Khalidi, 2023). There are also grounds for thinking that there is a proliferation of different theoretical constructs in the cognitive sciences, even when researchers use the same terms. Different subdisciplines, research programs, and indeed, labs will sometimes use a multiplicity of taxonomic categories and identify different kinds even when studying similar subject matters. But rather than see this ontological diversity as a drawback, some philosophers have called for *coordinated pluralism*, a collaborative effort to facilitate the emergence of new taxonomic categories (Sullivan, 2017).

Broader connections

There are open questions about the structure of natural kind concepts, especially when it comes to ascertaining whether they have a common structure and what it consists in, and determining the scope of natural kind concepts and the similarities and differences among concepts of living things, artifacts, and social phenomena (e.g., institutions, groups, professions). In addition, the ways in which human categorization and judgments of kindhood vary with context are worth exploring. Moreover, it is important to investigate further whether the structure of natural kind concepts helps or hinders epistemic endeavors, whether it encourages us to think in essentialist ways, and the role it plays in social cognition. It is also unclear whether psychological essentialism is always associated with kind concepts and whether it is a unitary phenomenon or multifaceted.

When it comes to the question of the existence of natural kinds in cognition, there is a great deal of work to be done on how best to delineate kinds in the cognitive sciences. There is also a need to understand the nature of the relationship between the constructs of neuroscience, psychology, linguistics, and related disciplines and sub-disciplines. This will involve understanding how different levels of explanation and description relate to each other in the cognitive sciences, such as the computational, algorithmic, and implementational levels (Marr, 1982). There is also scope for using quantitative methods and machine learning tools to investigate and isolate the relevant theoretical constructs in the cognitive sciences, bearing in mind the difference between correlational and causal relations.

The topic of natural kinds is related to a number of other important issues in the foundations of cognitive science, including the nature and structure of concepts, the process of concept acquisition, innate knowledge and biases, psychological essentialism, and social cognition and dehumanization. In a different way, it is related to the question of construct validity and operationalization of theoretical constructs in cognitive science, as well as questions of reductionism and eliminativism concerning cognitive constructs.

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