Natural Kind Essentialism

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Abstract

Natural kind essentialism is a specification of the intuitive idea that there are some mind-independent or objective categories in nature. These categories are thought to be characterised by a shared essence, which may involve intrinsic or extrinsic properties, mechanisms, or causal history. While the ontological basis of natural kinds has its roots in antiquity and especially Aristotle, the contemporary notion of a "natural kind" in philosophical discussion is often traced to William Whewell's and John Stuart Mill's work in the 1800s. In its more modern form, natural kind essentialism was popularised in the 1970s mainly by Saul Kripke and Hilary Putnam. Traditionally, natural kind essentialism has been associated with intrinsic and microstructural properties, but contemporary work has made it clear that more refined versions of natural kind essentialism may have to accept extrinsic or relational essences.

1. Introduction: What are Natural Kinds?

Natural Kind Essentialism (NKE) may be understood as a view about the essences of *natural kinds* themselves, the essences of the *members* of natural kinds, or both. At a general level, NKE is usually understood as the idea that there is something in common among the members of a given natural kind and that this commonality means that the members of the kind share a natural kind essence. On some views, this commonality is also *explained* by the shared essence.

This rough idea leaves much to be specified, but before we before get started, some initial observations should be made.

First, the distinction between *individual* vs. *general* essences is of crucial importance to NKE. Is it essential to an individual to be of kind *K*? I will set aside this question of essentialism regarding individuals.[1] Instead, I will understand Natural Kind Essentialism in terms of *general* essences: each member of a given kind *K* shares the same general essence of *K* (cf. Lowe 2008: 35). Every entity will have a general essence in the sense that it is a member of a given ontological category or kind, but it may or may not be essential to the individual that it is a member of that kind. This suggests that natural kind essences are not sufficient for individuating the distinct members of a natural kind.[2] The general essence of *K* may involve one or more properties that are essential to *K*'s members. But notice that if kinds are understood as something over and above their members (say, as *sui generis* universals, genuine entities in their own right), then we may also ask what is essential to the kind *K* (the entity, such as a universal) itself, rather than the *individuals* that instantiate the kind.

So, strictly speaking we can distinguish between three different but closely related views (cf. Bird and Tobin 2022 who distinguish two of these):

1) It is essential to individual *X* that it belongs to kind *K* (*individual essentialism*).
2) Each individual member of a given kind *K* has a *general* or *natural kind essence*, which may consist of one or more properties that are essential to all members of *K* (*NKE*).
3) The kind *K* (a *sui generis* entity) has an essence, which may also include the fact that each of its members have certain shared properties *(sui generis kind essentialism).*

(1)-(3) are logically independent, although some combinations may be more plausible than others and some views about what type of entities natural kinds are may constrain one's choices with regard to (1)-(3). There is also some intentional vagueness in the definitions of (2) and (3), since there are a variety of ways in which we may understand the relationship between natural kind essences and the essential properties that are definitive of the kind's members. Let me note one particularly interesting issue: the possibility of *kind change* (also noted, e.g., by Keinänen and Hakkarainen 2017, and Bird and Tobin 2022). For instance, is it possible for an individual cat to become a dog while retaining its individual essence, i.e., remaining the same entity? This type of change of species membership would violate (1) but not (2) (assuming that the shared essential properties of *K*'s members do not include the membership in *K*). Another potential example, from physics, is β^--decay, where weak interaction converts an atomic nucleus into a different atomic nucleus (atomic number increases by one). Markku Keinänen and Jani Hakkarainen (2017) mention one such case, namely, the possibility of the radioactive ^{14}C atom decaying into ^{14}N. Again, this would violate (1) but not (2).

Should we accept this type of kind change or remain committed to the essentiality of kind membership? This question is crucial for (1). One possibility would be to deny that there are individual essences like those of atomic nuclei or biological species, given that kind change may be possible in those cases. Alternatively, one might deny that there are any individual essences at all, but in this case (1) becomes redundant. However, I will focus on (2), which is the clearest sense of Natural Kind Essentialism. In contrast, if one assumes that natural kinds are *sui generis* universals, then (3) would concern the question of what is essential to universals of this type. This is certainly an interesting question, but one that concerns the metaphysics of ontological categories rather than Natural Kind Essentialism (see Keinänen and Tahko 2019, and Hommen 2021 for further discussion).

We should distinguish NKE from:

Dispositional Essentialism (DE), which is a view about properties, stating that at least some of them have dispositional essences, e.g., the tendency for negatively charged particles to attract positively charged particles (e.g., Bird 2007).[3]

Scientific Essentialism (SE), which is best understood as a collection of views about natural kinds and related topics, such as laws of nature (e.g., Ellis 2001).[4]

Many proponents of NKE also accept DE or SE. However, DE does not directly concern kinds, but rather properties. The case of negatively charged particles attracting positively charged particles could possibly be explained just with reference to the property charge, or its causal powers, which give rise to the relevant laws of nature. On the other hand, SE is a broader view, which may be considered to partially consist of a version of NKE.

I shall assume *realism* about natural kinds: we can't reduce natural kinds to some other type of entity. While I will be focusing on an essentialist characterisation of natural kinds, it may be useful to start with a more general account of what natural kinds are. Let me quote a classic passage from John Stuart Mill:

> In so far as a natural classification is grounded on real Kinds, its groups are certainly not conventional; it is perfectly true that they do not depend upon an arbitrary choice of the naturalist (Mill 1843: 720).

Setting aside the details of Mill's own view, which was not essentialist, the key thought is that natural kinds track or reflect some natural or 'objective' divisions in mind-independent reality (they 'carve at the joints') (cf. Psillos 2002, Devitt 2005, Lowe 2006, Chakravartty 2007, Tahko 2015a, Bird and Tobin 2022).[5] I should immediately note that the mind-independence criterion has recently received increasing scrutiny (see, e.g., Franklin-Hall 2015, Khalidi 2016, Ereshefsky 2018, and Tahko 2022). Nevertheless, realism about natural kinds must be associated with some sense of 'objectivity', in contrast to various forms of *conventionalism* and *conferralism* about natural kinds.[6] Moreover, my focus will be on the metaphysics of natural kinds rather than on the semantics of natural kind terms, although in some cases these two issues are very closely intertwined (see Koslicki 2008 on this distinction, and Häggqvist and Wikforss 2018 for a contemporary take). As Nathan Salmon (2005) famously argues, we cannot derive metaphysical essentialism from semantic arguments.

Kinds may be conceived as *simple* or *complex* universals, *sui generis* entities, homeostatic property clusters, bundles of (natural) properties, fundamental ontological categories (substantial universals), Aristotelian (instantiated) vs. Platonic (uninstantiated) universals, and so on (for examples, see Boyd 1999, Ellis 2001, Lowe 2006, Hawley and Bird 2011, and Hommen 2021). I will be concentrating on classical examples of natural kinds, drawn primarily from the fields of physics, chemistry, and biology, i.e., the 'natural' sciences – I will not be discussing psychological or social kinds. Traditionally, discussion of such 'higher-level' kinds has had anti-realist connotations, although contemporary literature on natural kinds is less constrained in this regard, and there is no reason in principle why an account of natural kinds could not be extended to cover higher-level kinds as well (see, e.g., Mallon 2016 for a realist account of 'human kinds', i.e., kinds such as mental kinds, which have properties that can be altered by human activity).[7]

Finally, how do we understand *essence* or *essentialism* more generally? This is a topic that comes up throughout this volume and in its introduction, so I will not pursue it here. Many of the versions of NKE that I will discuss assume a modal conception of essence, while some assume a non-modal conception.[8] I will not attempt to determine the implications of assuming one or the other view of essence, but it is worth noting that the historical background, from Kripke and Putnam, is intertwined with the modal conception, whereas some contemporary authors (e.g., Kit Fine, E. J. Lowe, Kathrin Koslicki, and Tuomas Tahko) prefer the non-modal conception.

2. The Kripke-Putnam Framework

Natural kind essentialism was popularized by Saul Kripke (1980) and Hilary Putnam (1975). Their views are often discussed in parallel, but in fact there are important differences, which Putnam (1990) later specified. Putnam expressed doubts about extending his famous Twin Earth scenario across metaphysically possible worlds. The Twin Earth scenario asks us to imagine a planet identical with Earth in every way except for one detail: Instead of water, Twin Earth has a substance that has every superficial characteristic of water, but a radically different molecular constitution, XYZ. So, XYZ is superficially like water, but has a different *intrinsic* structure. In this scenario, the chemical properties of water are reproduced by some molecular structure other than H_2O, namely, XYZ, which is a placeholder for some potentially complex chemical structure.[9] Should we consider this substance to be water? The expected reaction is to deny that XYZ is water.

On the usual reading of the Twin Earth scenario, the metaphysical possibility of XYZ reproducing the chemical properties of water in some world with alternative laws of physics is assumed, but the conclusion that we are expected to draw from the scenario is that water has its microstructure essentially, where ‘microstructure’ is a placeholder for whatever determines the chemical properties of water. The interpretation of the Twin Earth scenario in the context of natural kind essentialism is, however, controversial (as discussed in Tahko 2015a). Putnam later suggested that the question about the possible variation of the laws of physics with regard to water ‘makes no sense’, mainly because of his general suspicion of metaphysical modality (Putnam 1990, p. 70). The suggestion is that we should conceive of the Twin Earth scenario as concerning a remote location in our own universe instead. In contrast, Putnam reads Kripke to be concerned with the stronger reading, involving metaphysical necessity.

It is important to note both the exegetical issue as well as its implications for the strength of the underlying claim regarding natural kind essentialism: do natural kinds have their microstructure by *metaphysical* necessity (i.e., essentially, given that Kripke and Putnam operate with the modal notion essence) or merely by nomological necessity? This is a question that is closely related to the debate about laws of nature and the discussion regarding Dispositional Essentialism (DE) and Scientific Essentialism (SE). Many proponents of DE, such as Alexander Bird (e.g., 2007, 2018), and the main proponent of SE, Brian Ellis (e.g., 2001), favour a view according to which laws of nature are metaphysically necessary (where the relevant properties/kinds exist). This suggests that natural kinds like water may have their microstructure by metaphysical necessity, as there are scientific reasons to think that a variation in microstructure while retaining the chemical properties of water is not physically possible (see Tahko 2015a). However, some favour a view whereby at least some laws may be metaphysically contingent (e.g., Lowe 2006), which leaves this issue open (albeit Lowe himself thinks that natural kinds and metaphysically necessary laws are closely linked; see Tahko 2015b for discussion).

Setting aside these complications, the standard interpretation of what may be called Kripke-Putnam Essentialism about kinds (without necessarily associating this with the actual, considered view that either Kripke or Putnam may have held) may understood as follows:

> *Kripke-Putnam Essentialism* (KPE): if every member or sample of the kind *K* possesses property *p*, in every possible world, then possession of property *p* is part of the essence of the kind *K*, i.e., *p* is an essential property of *K*.

KPE is often associated with the view that the essential properties of kinds are *intrinsic* and *microstructural*, although as we will see, both of these assumptions can and should be questioned. In Kripke's work, an important part of the background is that theoretical identity statements such as 'Water is H_2O' should be understood as identities involving *rigid designators*, making them *metaphysically necessary*. Rigid designators in general, such as proper names, pick out the same individual in all possible worlds where that individual exists. Since water was discovered to be H_2O with the help of empirical research, this makes 'Water is H_2O' an *a posteriori* metaphysical necessity. Another classic example, also from Kripke, is the association between a chemical element and its atomic number, e.g., 'gold is the element with atomic number 79'. However, it is controversial whether natural kind terms are rigid designators (for discussion, see, e.g., LaPorte 2004, 2012, Soames 2005, Linsky 2006, and Schwartz 2021). For the purposes of outlining the traditional KPE view, let us nevertheless assume that terms like 'water' and 'gold' are rigid, which entails that in every possible world in which gold exists, its atomic number is 79.

Let me now summarise the reasoning behind KPE in a more systematic fashion. It's a key part of the view that we start from some empirical information. Next, we include the assumption that natural kind terms like ‘water’ are rigid designators and pick out the same microstructure in all possible worlds – this is in line with Kripke, but Putnam’s Twin Earth scenario can be used to further support the underlying intuition, controversial as it may be. If we additionally grant that essential truths are simply truths that hold in all possible worlds (the modal view of essence), then it follows that water has its actual microstructure essentially, and thus ‘Water is H_2O’ is a metaphysically necessary *a posteriori* essentialist truth. This is something that is traditionally thought to be supported by *the necessity of identity*: if *x* and *y* are the same object then it is necessary that they are the same object (see Kripke 1971). The necessity of identity is often considered to be knowable *a priori*. In summary, the following steps lead us toward KPE (although these are not presented as a logical argument here):

1) An empirical discovery leading to an *a posteriori* theoretical identity statement S, which associates property *p* (and only *p*) with every sample/member of kind *K* in the actual world.

2) A general *a priori* principle about the necessity of identity and rigid designation: if the terms “a” and “b” are rigid designators and the objects that they designate are identical, then they are necessarily identical.

3) The statement S involves rigid designators on both sides of the identity and hence expresses a metaphysically necessary, *a posteriori* identity.

4) Since S states a metaphysically necessary theoretical identity, *K* possesses property p in every possible world and hence the possession of property *p* is part of the essence of *K*, i.e., *p* is an essential property of *K*.

Each of these steps can be questioned (perhaps with the exception of the first, empirical generalisation), and they all involve significant background assumptions. Besides the already mentioned issue regarding intrinsicness (to be discussed in section 3) and the assumption that natural kind terms act as rigid designators, these steps can be questioned on the basis of the underlying assumptions about the connection between microstructural properties and the chemical (superficial) properties of chemical elements like water (to be discussed in section 4), as well as the role of *a priori* vs. *a posteriori* content. On the last issue, further scrutiny should be given to (2), i.e., the claim that the only *a priori* content that is needed to establish supposed metaphysically necessary identities like 'Water is H_2O' concerns the necessity of identity. It is arguable that further *a priori* content about the essence of natural kinds would be required, i.e., that there is a necessary connection between the chemical properties of a chemical substance and the microstructure of that substance (see the addenda to Kripke 1980, and Tahko 2009, 2015a, as well as section 4 for further discussion).

Let us now move on to a more detailed discussion about the role of intrinsic vs. extrinsic essences in the context of natural kind essentialism.

3. Intrinsic vs. Extrinsic Essences

Traditional examples of natural kind essentialism tend to mention cases like chemical elements and compounds, which are commonly defined in terms of their intrinsic properties, such as their nuclear charge and molecular composition. The notion of an intrinsic property is familiar from David Lewis, who suggests that they are properties 'which things have in virtue of the way they themselves are' (Lewis 1986: 61). Extrinsic properties are properties which things have in virtue of their relations to other things. There are well-known issues concerning the precise understanding of intrinsicness (e.g., Sider 1996), but it will become clear that some natural kind essences would seem to have non-intrinsic elements. So, something must be said about the possibility of extrinsic or relational essences. The need for extrinsic or relational essences has also been recognized in contexts such as the essences of artworks and other artifacts (see Baker 2000).[10]

The view that natural kind essences must be intrinsic is commonly associated with Kripke and Putnam (see, e.g., Okasha 2002 and Needham 2011), but it may not be fully accurate (see LaPorte 2004 and Williams 2011). Neither Kripke nor Putnam formulated intrinsic natural kind essentialism explicitly, but it is clear from their examples that some internal structure was assumed to be the defining or most important characteristic of many natural kinds, and this is likely to have led to the conception that all natural kind essences are intrinsic. Consider the following passage from Okasha:

> [B]oth Putnam and Kripke appear to believe that essential properties of species can be found if we penetrate beyond the "superficial characteristics" of organisms into their "hidden structure". Thus Putnam (1975) claims that the true criterion for being a lemon is having the "genetic code" of a lemon – this, rather than any observable traits, is the essence of lemonhood, he claims (p. 240). Similarly, Kripke (1980) maintains that having the right "internal structure" is the true criterion for being a tiger – this shared "internal structure" is the essence of tigerhood, he thinks (p. 121). (Okasha 2002: 198.)

It is not difficult to find individual examples or passages from Kripke and Putnam that corroborate the interpretation that they consider natural kind essences to be intrinsic. Consider Putnam's treatment of lemons and acids, where the 'essential nature' is stated to be 'chromosome structure, in the case of lemons, and being a proton-donor, in the case of acids'

(Putnam 1970: 188). The idea that chromosome structure or similar intrinsic features would conclusively capture the essence of biological species is of course a very controversial claim, and one of the main reasons why intrinsic natural kind essentialism has been subjected to criticism, as seen above.[11] Similar criticisms can be raised for chemical kinds as well (van Brakel 1986, VandeWall 2007, and Needham 2011). The case of acids is worth a specific mention. Strictly speaking, being a proton-donor does not look like a purely intrinsic or even a microstructural property, as it suggests that there is something that the proton is being donated to. Indeed, the definition of acids (and bases) has gone through a variety of changes involving both micro- and macroscopic characteristics (Stanford and Kitcher 2000: 115 ff.; see also Tahko 2020: 810).

Neil Williams has pointed out that Putnam seems to have accepted diseases as natural kinds, and further, that 'natural kinds of disease could turn out to have (or do in fact have) a cause as their essence' (Williams 2011: 155). Williams continues:

> As these causes are partly, if not entirely, extrinsic to the disease instances, the causal relation can be translated into a (non-intrinsic) relational property of the disease instances, from which it follows that the essences of certain natural kinds are relational (and non-intrinsic). (Williams 2011: 155.)

If Williams is right, then it would seem that Kripke-Putnam Essentialism (KPE)'s association with intrinsic (and microstructural) essences may have been overstated. Or perhaps more accurately: KPE does not necessarily reflect the commitments of Putnam (or Kripke). So, natural kind essentialism does not need to be as closely tied to intrinsic essences as it is sometimes perceived to be. This point has been forcefully made in the literature (e.g., Boyd

1999, Griffiths 1999, Millikan 1999, Okasha 2002, LaPorte 2004, and Brigandt 2009). For instance, Samir Okasha (2002) has argued that natural kind essentialism can be maintained even in the biological context if we accept relationally defined kinds (and hence extrinsic or relational essences). In this context, the causal history or etiology associated with evolutionary process is thought to be in a key role. We may generally talk of *etiological kinds* to capture those kinds whose members share a common causal history or origin (see Khalidi 2021). Besides biological species (and other biological cases), potential examples include, e.g., cosmological and geological kinds, which are commonly defined at least in part in terms of their causal history (see also Cleland, Hazen, and Morrison 2021).

Extrinsic or relational features may however manifest in other ways as well, not necessarily just in terms of etiology or causal history. Recent work on chemical and biochemical kinds has made this quite clear (e.g., Hendry 2006, Tobin 2010, Needham 2011, Tahko 2015a, Bartol 2016, Havstad 2018, and Tahko 2020). Consider this passage from Emma Tobin on 'moonlighting' proteins:

> Some proteins "moonlight" and thus, perform a secondary function in different parts of the organism. There are two types of moonlighting protein: extrinsically structured moonlighting (ESM) and intrinsically unstructured moonlighting (ISM). Extrinsic cases of moonlighting are cases where extrinsic contextual factors affect the functional role of the protein. An example is the presence of globular crystallin proteins, which have two functional roles. These play a structural role in the lens of the eye, and also act as a catalytic enzyme elsewhere in the organism. (Tobin 2010: 42.)

The functional role of these proteins does not appear to be purely intrinsic, given that it relates to the protein’s behaviour in a certain context, such as the lens of the eye in Tobin’s example. Moreover, biological functions themselves are commonly analysed in terms of their etiology, and indeed some have argued that ‘history’ is an unavoidable element of theories of function (Garson 2019, see also Bartol 2016). But insofar as the biological function of, say, proteins, is part of their essence, we need to account for this aspect as well. Even if intrinsicality cannot be easily maintained, the case of (ESM) described above does not necessarily undermine *microstructural* essentialism. As Tobin notes, the microstructuralist could perhaps accommodate these cases ‘since alternative functional roles are determined by changes in the molecular environment (such as localization, ligand binding and so on)’ (Tobin 2010: 42). Yet, Tobin does think that (ISM) is a more serious problem for microstructuralism. In this regard, the debate continues (see Goodwin 2011, Havstad 2018, and Tahko 2020).

Finally, there have recently been some attempts to revitalise (at least partially) intrinsic biological essentialism (e.g., Devitt 2008, Dumsday 2012, and Austin 2018). Interesting as these attempts are, I will have to omit a more detailed discussion here.[12]

4. Microstructural Essences

Even though intrinsic essences and microstructural essences seem to be closely linked, there may be cases where these two come apart. Interestingly, traditional Kripke-Putnam essentialism focuses on superficial or phenomenological, i.e., *macroscopic* properties, but takes the (potentially intrinsic) *microstructure* to be definitive of the kind. It is then a further question whether these two can come apart, that is, whether or not there is a 1:1 correlation between the microstructure and the macroscopic properties. *Microstructural essentialism* is the view that prioritises microstructure. In fact, the commitment to microstructural essentialism has been so central that, for some, the failure of finding determinate microstructural essences has led to the rejection of higher-level natural kinds, such as biological kinds (Ellis 2001). But as we saw in the previous section, not all apparent threats to microstructuralism are as serious as they may first seem. The core of the problem is that microstructuralism is often understood in a simplified fashion, e.g., not taking into account the 3D-shape of molecules (cf. Tobin 2010, Havstad 2018). Moreover, a sophisticated version of microstructuralism also ought to consider the fact that the same compositional formula of molecules like H_2O can be divided into different isomers (i.e., distinct substances with the same compositional formula). One possibility would be to understand the 'sameness' of microstructure in a more fine-grained sense, taking into account possible stereoisomers, structural isomers, and so on (see Weisberg 2005 and Tahko 2015a for discussion). Microstructuralism is often also associated with intrinsic essences, but it does not necessarily entail that all microstructural properties must be intrinsic, as we've just seen in the case of biological functions in section 3.

Recent work on natural kinds has taken a strong stand against microstructuralism. One of the more sophisticated versions of microstructuralism has been put forward by Robin Hendry (2006: 872), who suggests that 'water is the substance formed by bringing together H_2O molecules and allowing them to interact spontaneously' – the thought here is that in order to account for the properties of water, we need to consider the interactions between the molecules in a body of water. In his forceful critique of microstructuralism, Paul Needham (2011: 16) cites this very passage, but remains unsatisfied of the need for microstructuralism, stating that even if microstructure is indeed present, it doesn't follow that 'the details of the microstructure of any particular substance are reasonably well known, and certainly not that they are independent of macroscopic constraints or somehow determine the macroscopic features of substances or that substances are in some clear sense "nothing but" their microconstituents'.

Needham is right to point out the presence of macroscopic constraints as well as the difficulty of specifying what the microstructure of a substance involves in any given case – even if there are some relatively easy cases as well. We saw that in the classic version of natural kind essentialism, which is often associated (right or wrongly) with Kripke and Putnam, it is considered to be knowable *a priori* that substances such as water have their actual microstructure essentially. But how exactly should we understand the requirements of microstructural essentialism? In particular, does microstructural essentialism require that microstructure *determines* the macroscopic features of substances in the sense that Needham seems to assume? It may be that something weaker is sufficient. Consider the following two claims (cf. Tahko 2015a: 804):

(1) Necessarily, there is a 1:1 correlation between (all of) the chemical properties of a chemical substance and the microstructure of that substance.

(2) Necessarily, a sample of chemical substance A is of the same chemical substance as B if and only if A and B have the same microstructural composition.

Notice that neither (1) nor (2) explicitly say anything about the type of connection – say, dependence or determination – that holds between microstructure and macroscopic features. Thinking back to Putnam's Twin Earth scenario, it seems to focus on (2) rather than (1), since the scenario concerns a case where we encounter a substance, XYZ, which replicates the chemical properties of water. Interestingly, for the Twin Earth scenario to be possible at all, we would have to assume the falsity of (1), since we would then have two microstructures that are associated with (all of) the same chemical or macroscopic properties – a many:1

relationship. While this may be of relatively little consequence regarding the upshot for the semantics of natural kind terms that Putnam was mainly interested in, it does make a difference for the metaphysical reading of the scenario that Kripke and others may have had in mind. The most plausible way around this complication is to read the Twin Earth scenario as concerning merely the *epistemic* possibility of encountering a substance like water with a different microstructure, and to read (2) in terms of physical necessity, as Putnam (1990: 69) seems to have intended.

What about (1)? Importantly, even if a correlation between microstructure and chemical properties does exist, it might not always be possible to specify the microstructure without relying on macroscopic features, like Needham has argued. We have good reasons to think that there is no general formula according to which microstructure determines macroscopic features. So, if microstructural essentialism holds any promise, we must understand it in a more restricted sense than it has been traditionally understood – this seems to be the consensus in recent work (e.g., Tobin 2010, Tahko 2015a, Bartol 2016, Havstad 2018, and Tahko 2020).

5. Refined Natural Kind Essentialism

Let us finish by considering more refined or restricted versions of natural kind essentialism. Consider a recent proposal from Godman, Mallozzi, and Papineau (2020), which is Kripkean in spirit. They suggest that to be an essential property is to be a *super-explanatory property*. On this view, natural kinds (or their properties) are typically 'unified by certain super-explanatory core properties' (Godman, Mallozzi, and Papineu 2020: 2). Such a core property, they propose, is some single property which causally explains the occurrence of the multiple properties shared by instances of a kind. One example they provide is the property of atomic constitution, say, of gold, which explains why all samples of solid gold have the same chemical and physical properties. This proposal has clear connections to Richard Boyd's homeostatic property cluster (HPC) theory, which has been previously developed in a more essentialist framework by Kathrine Hawley and Alexander Bird (2011).

According to the HPC theory, the clustering of properties in members of natural kinds is explained by a shared causal structure among the members of a natural kind; each member of a kind is a property cluster kept in homeostasis by a (often lower-level) causal mechanism. There have been many different versions of this type of causal account of natural kinds (e.g., Khalidi 2013). However, Godman, Mallozzi and Papineu specify that where they differ from the usual causal accounts is that, on their view, 'the great preponderance of natural kinds owe their clustering of properties, not just to some causal structure or other, but to one single underlying property that serves as the common cause of all the other clustered properties' (2020: 6). Importantly, the relevant super-explanatory properties may in some cases be intrinsic and microstructural, but Godman, Mallozzi and Papineu also accept the possibility of shared causal history serving the super-explanatory role.

Godman, Mallozzi and Papineu conclude by saying that their aim is to reduce kind essences to 'a specific kind of nomological structure', namely, their super-explanatory role (2020: 14). The resulting view is interesting, but highly controversial:

> [I]t is a consequence of our view that modal Kind essences would stay fixed even in possible worlds where the relevant laws of nature were different. Even if variation in laws of nature meant that H_2O were no longer odorless, colorless, tasteless, and so on, it would still be *water*.

This result of the view is in clear tension with those accounts of natural kind essentialism which argue that there is a *metaphysically necessary* connection between the core properties such as molecular composition and the macroscopic properties of the kind. Compare this with David Oderberg's neo-Aristotelian essentialist account, whereby the properties that 'flow' from the essence of a particular object belonging to a given kind are *caused by* and *originate* in the *form* of that kind (Oderberg 2011: 99–103).[13] We should be careful here though. For what reason do we have to think that there are any *causal* connections between the essential properties of natural kinds such as, say, *electron* – or indeed between the kind itself and the properties of its members? In other words, why should we think that either the kind itself or its super-explanatory property (or core properties, if we accept more than one) *causally* explain why the properties of a natural kind cluster together? There is no scientific evidence that would suggest such a connection in cases like *electron* or other supposedly fundamental kinds, and indeed some, like Anjan Chakravartty (2007: 171), have suggested that fundamental natural kinds, such as electrons, have their core properties (mass, charge, spin) as a matter of brute fact.

A generalised version of the HPC theory or something in the lines of Godman, Mallozzi and Papineau's proposal would seem to go toward providing this type of explanation: each kind is a property cluster kept in homeostasis by a causal mechanism, which could be anything from nucleosynthesis to DNA synthesis. But while the HPC theory has been very popular, it is also clear, and well-known, that the account is unlikely to apply to all natural kinds (see, e.g., Khalidi 2013: sec. 2.6). For instance, it is difficult to see what kind of causal mechanism could be postulated to be responsible for the resemblance amongst chemical elements: a shared atomic number and nuclear charge are not mechanisms in HPC's sense, but rather just individual properties. The case of supposedly fundamental kinds like *electron* constitutes even stronger evidence against this type of account because of the lack of causal links between the kind and its properties or indeed among any of the properties. This latter objection seems equally challenging for Godman, Mallozzi and Papineau's account. One possible reaction is that some form of pluralism about natural kinds is required, i.e., that different epistemic or theoretical interests entail different accounts of kinds (for discussion of pluralism in the chemical context, see Hendry 2012, and in a biochemical context, Bartol 2016).

Either way, I believe that the issue regarding the connection between a natural kind and the properties of its members, or the 'unity problem' as Oderberg (2011: 90) calls it, is still at the heart of natural kind essentialism: 'Why, in the case of a *K* with putative essential properties *F*, *G*, and *H*, are those properties always and only found together in the *K*s, assuming that the essential properties specify what a *K* is such as to distinguish *K*s from every other kind of thing?' (ibid.).[14] For example, if it is essential to the kind *electron* that its members have unit negative charge, then what exactly is the relationship between the property of unit negative charge and the essence of the kind *electron*? Is the essence of the kind something over and above the essential properties of the kind's members, and if so, what? In asking this question, we have returned to some of our initial distinctions, specifically the distinction between *natural kind essentialism* as I defined it and *sui generis kind essentialism*, according to which the kind *K* (a sui generis entity) has an essence. We need a clearer sense of these issues especially when faced with the problems that the causal accounts have encountered. Unfortunately, a deeper analysis of the prospects for giving such an account will have to take place elsewhere.[15]

Notes

[1] See Penelope Mackie's "Individual vs. Kind Essences" and Teresa Robertson's "Origin Essentialism".
[2] See Maria Scarpati's "Identity, Persistence, and Individuation".
[3] See Ka Ho Lam's "Dispositional Essentialism".
[4] See Travis Dumsday's "Scientific Essentialism".
[5] The phrase 'carves at the joints' originates in Plato's Phaedrus 265e.
[6] See Alan Sidelle's and Jonathan Livingstone-Banks' "Conventionalism", and Anand Vaidya and Michael Wallner's "Conferralism".

[7] See Asya Passinky's "Artworks, Artifacts, and Other Social Kinds", Danielle Brown's "Psychology/Psychiatry", Ron Mallon's "Race", and Esther Rosario's "Sex and Gender".

[8] See Nathan Wildman's "Modal Conceptions of Essence" and Fabrice Correia's "Non-modal Conceptions of Essence".

[9] What is a 'chemical property'? Putnam was originally interested in the macroscopic, phenomenological properties such as boiling point or solubility. Whether these reduce to microscopic properties such as electron configuration is debatable (Needham 2011). I define a chemical property as a property of a chemical substance in virtue of which the substance can undergo chemical reactions, but plausibly these properties also determine the phenomenological properties (Tahko 2015a: 802).

[10] See Asya Passinsky's "Artworks, Artifacts, and Other Social Kinds".

[11] See Ingo Brigandt's "Biological Species".

[12] See Ingo Brigandt's "Biological Species".

[13] See also Kimpton-Nye 2021 for a different route to a similar result, via *modal necessitarianism*, the view according to which all worlds are nomologically identical.

[14] See also Dumsday 2010 on 'complex essences' and Hommen 2021.

[15] See Tahko 2015a, 2020, 2021, 2022, and Keinänen and Tahko 2019.

Related Topics

- Nathan Wildman: “Modal Conceptions of Essence”
- Fabrice Correia: “Non-modal Conceptions of Essence”
- Penelope Mackie: “Individual vs. Kind Essences”
- Teresa Robertson: “Origin Essentialism”
- Travis Dumsday: “Scientific Essentialism”
- Ka Ho Lam: “Dispositional Essentialism”
- Asya Passinsky: “Artworks, Artifacts, and Other Social Kinds”
- Ingo Brigandt: “Biological Species”

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References

Austin, C. J. (2018) *Essence in the Age of Evolution: A New Theory of Natural Kinds*, New York and London: Routledge.

Baker, L. R. (2000) *Persons and Bodies: A Constitution View*, Cambridge: Cambridge University Press.

Bartol, J. (2016) “Biochemical Kinds,” *British Journal for the Philosophy of Science* 67: 531–51.

Bird, A. (2018) “The Metaphysics of Natural Kinds,” *Synthese* 195: 1397–1426.

Bird, A. and Tobin, E. (2022) “Natural Kinds,” in Zalta, E. N. (ed.) *Stanford Encyclopedia of*

Philosophy, (Spring 2022 Edition), URL = <https://plato.stanford.edu/archives/spr2022/entries/natural-kinds/>.

Boyd, R. (1999) "Homeostasis, Species, and Higher Taxa," in R. A. Wilson (ed.) *Species: New Interdisciplinary Essays*, Cambridge, MA: MIT Press, pp. 141–185.

Brigandt, I. (2009) "Natural Kinds in Evolution and Systematics: Metaphysical and Epistemological Considerations," *Acta Biotheoretica* 57 (1–2): 77–97.

Chakravartty, A. (2007) *A Metaphysics for Scientific Realism: Knowing the Unobservable*, Cambridge: Cambridge University Press.

Cleland, C. E., Haze, R. M., and Morrison, S. M. (2021) "Historical Natural Kinds and Mineralogy: Systematizing Contingency in the Context of Necessity," *PNAS* 118 (1): 1–9.

Devitt, M. (2005) "Scientific Realism," in F. Jackson and M. A. Smith (eds.) *Oxford Handbook Of Contemporary Philosophy*, Oxford: Oxford University Press, pp. 767–791.

Devitt, M. (2008) "Resurrecting Biological Essentialism," *Philosophy of Science* 75: 344–382.

Dumsday, T. (2010) "Natural Kinds and the Problem of Complex Essences," *Australasian Journal of Philosophy* 88 (4): 619–634.

Dumsday, T. (2012) "A New Argument for Intrinsic Biological Essentialism," *Philosophical Quarterly* 62 (248): 486–504.

Ellis, B. (2001) *Scientific Essentialism*, Cambridge: Cambridge University Press.

Ereshefsky, M. (2018) "Natural Kinds, Mind Independence, and Defeasibility," *Philosophy of Science* 85: 845–856.

Franklin-Hall, L. (2015) "Natural Kinds as Categorical Bottlenecks," *Philosophical Studies* 172: 925–948.

Garson, J. (2019) "There Are No Ahistorical Theories of Function," *Philosophy of Science* 86:

1146–1156.

Godman, M., Mallozzi, A., and Papineau, D. (2020) “Essential Properties Are Super-Explanatory: Taming Metaphysical Modality,” *Journal of the American Philosophical Association* 6: 316–334.

Goodwin, W. (2011) “Structure, Function, and Protein Taxonomy,” *Biology and Philosophy* 26: 533–545.

Griffiths, P. E. (1999) “Squaring the Circle: Natural Kinds with Historical Essences,” in R. A. Wilson (ed.) *Species: New Interdisciplinary Essays*, Cambridge, MA: MIT Press, pp. 208–228.

Havstad, J. C. (2018) “Messy Chemical Kinds,” *British Journal for the Philosophy of Science* 69: 719–743.

Hawley, K. and Bird, A. (2011) “What Are Natural Kinds?” *Philosophical Perspectives* 25: 205–221.

Hendry, R. F. (2006) “Elements, Compounds, and Other Chemical Kinds,” *Philosophy of Science* 73: 864–875.

Hendry, R. F. (2012) “Chemical Substances and the Limits of Pluralism,” *Foundations of Chemistry* 14: 55–68.

Hommen, D. (2021) “Kinds as Universals: A Neo-Aristotelian Approach,” *Erkenntnis* 86: 295–323.

Häggqvist, S. and Wikforss, Å. (2018) Natural Kinds and Natural Kind Terms: Myth and Reality,” *British Journal for the Philosophy of Science* 69 (4): 911–933.

Keinänen, M. and Hakkarainen, J. (2017) “Kind Instantiation and Kind Change - A Problem for Four-Category Ontology,” *Studia Neoaristotelica* 14 (2): 139–165.

Keinänen, M. and Tahko, T. E. (2019) “Bundle Theory with Kinds,” *Philosophical Quarterly* 69 (277): 838–857.

Khalidi, M. A. (2013) *Natural Categories and Human Kinds: Classification in the Natural and Social Sciences,* Cambridge: Cambridge University Press.

Khalidi, M. A. (2016) “Mind-Dependent Kinds,” *Journal of Social Ontology* 2: 223–246.

Khalidi, M. A. (2021) “Etiological Kinds,” *Philosophy of Science* 88 (1): 1–21.

Kimpton-Nye, S. (2021) “Laws of Nature: Necessary and Contingent,” *Philosophical Quarterly,* forthcoming. Doi: 10.1093/pq/pqab062.

Koslicki, K. (2008) “Natural Kinds and Natural Kind Terms,” *Philosophy Compass* 3/4: 789–802.

Kripke, S. (1971) “Identity and Necessity,” in M. K. Munitz (ed.) *Identity and Individuation,* New York, NY: New York University Press, pp. 135–164.

Kripke, S. (1980) *Naming and Necessity*, Cambridge, MA: Harvard University Press.

LaPorte, J. (2004) *Natural Kinds and Conceptual Change*, Cambridge: Cambridge University Press.

LaPorte, J. (2012) *Rigid Designation and Theoretical Identities*, Oxford: Oxford University Press.

Lewis, D. (1986) *On the Plurality of Worlds*, Blackwell, New York.

Linsky, B. (2006) “General Terms as Rigid Designators,” *Philosophical Studies* 128 (3): 655–667.

Lowe, E. J. (2006) *The Four-Category Ontology: A Metaphysical Foundation for Natural Science,* Oxford: Oxford University Press.

Lowe, E. J. (2008) “Two Notions of Being: Entity and Essence,”, *Royal Institute of Philosophy Supplements* 83 (62): 23–48.

Mallon, R. (2016) *The Construction of Human Kinds,* Oxford: Oxford University Press.

Mill, J. S. (1843) *A System of Logic, Ratiocinative and Inductive,* in J. M. Robson (ed.) *Collected Works of John Stuart Mill,* Toronto: University of Toronto Press and London:

Routledge and Kegan Paul, 1974.

Millikan, R. G. (1999) “Historical Kinds and the ‘Special Sciences’,” *Philosophical Studies* 95: 45-65.

Needham, P. (2011) “Microessentialism: What is the Argument?” *Noûs* 45: 1–21.

Oderberg, D. (2011) “Essence and Properties,” *Erkenntnis* 75: 85–111.

Okasha, S. (2002) “Darwinian Metaphysics: Species and the Question of Essentialism,” *Synthese* 131: 191–213.

Psillos, S. (2002) *Causation and Explanation*, Montreal: McGill-Queen University Press.

Putnam, H. (1970) “Is Semantics Possible?” *Metaphilosophy* 1 (3): 187–201.

Putnam, H. (1975) “The Meaning of “Meaning”,” in Putnam 1979, *Mind, Language and Reality: Philosophical Papers, Vol. 2*, Cambridge University Press, pp. 215–271.

Putnam, H. (1990) “Is Water Necessarily H_2O?” In J. Conant (ed.) *Realism with a Human Face*, Cambridge, MA: Harvard University Press, pp. 54–79.

Salmon, N. U. (2005) *Reference and Essence*, second edition, New York: Prometheus Books.

Schwartz, S. P. (2021) “Against Rigidity for Natural Kind Terms,” *Synthese* 198: 2957–2971.

Soames, S. (2005) *Reference and Description: The Case Against Two-Dimensionalism*, Princeton: Princeton University Press.

Tahko, T. E. (2009) “On the Modal Content of A Posteriori Necessities,” *Theoria: A Swedish Journal of Philosophy* 75 (2): 344–357.

Tahko, T. E. (2015a) “Natural Kind Essentialism Revisited,” *Mind* 124: 795–822.

Tahko, T. E. (2015b) “The Modal Status of Laws: In Defence of a Hybrid View,” *Philosophical Quarterly* 65 (260): 509–528.

Tahko, T. E. (2020) “Where Do You Get Your Protein? Or: Biochemical Realization,” *British Journal for the Philosophy of Science* 71 (3): 799–825.

Tahko, T. E. (2021) *Unity of Science*, Elements in Philosophy of Science, Cambridge:

Cambridge University Press.

Tahko, T. E. (2022) "Natural Kinds, Mind-Independence, and Unification Principles," *Synthese* 200, 144.

Tobin, E. (2010) "Microstructuralism and Macromolecules: The Case of Moonlighting Proteins," *Foundations of Chemistry* 12: 41–54.

Sider, T. (1996) "Intrinsic Properties," *Philosophical Studies* 83: 1–27.

Stanford, P. K. and Philip K. (2000) "Refining the Causal Theory of Reference for Natural Kind Terms," *Philosophical Studies* 97: 99–129.

van Brakel, J. (1986) "The Chemistry of Substances and the Philosophy of Mass Terms," *Synthese* 69: 291–324.

VandeWall, H. (2007) "Why Water Is Not H_2O, and Other Critiques of Essentialist Ontology from the Philosophy of Chemistry," *Philosophy of Science* 74: 906–919.

Weisberg, M. (2005) "Water is Not H_2O," in D. Baird, E. Scerri, and L. McIntyre (eds.) *Philosophy of Chemistry: Synthesis of a New Discipline*, New York: Springer, pp. 337–345.

Williams, N. E. (2011) "Putnam's Traditional Neo-Essentialism," *Philosophical Quarterly* 61: 151–170.

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