

# Away with Dispositional Essences in Trope Theory

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## 1. Introduction

As argued by Giacomo Giannini and Stephen Mumford elsewhere in this volume, dispositional essentialism is a specific variety of the doctrine of formal causation. Dispositional essentialism is ontologically committed to powers as irreducibly dispositional properties. Giannini & Mumford argue that powers are formal causes that ground certain kind of formal explanations such as that it (roughly) flows from the essence of H<sub>2</sub>O that water boils at 100°C. In this paper, we show that trope bundle theories ('trope theories', for short) committed to the primitive individuation of tropes are incompatible with dispositional essentialism. Such theories are Keith Campbell's and Douglas Ehring's views, and our *Strong Nuclear Theory*. In this specific sense, these theories cannot therefore be committed to formal causation or formal explanations. Neither does our theory represent a formal causation position in the form that substances have dispositional properties in virtue of the kinds of tropes or substances. We also give reasons independent from the above mentioned for thinking that the wedding of trope theory and dispositional essentialism is not a happy marriage at all.

According to Dispositional Essentialism, every fundamental physical property has a certain causal profile essentially. For instance, it is part of the essence of electric charges that objects having electric charges behave in accordance with Maxwell's equations. Dispositional essentialism is a currently popular conception of the fundamental properties because it provides us with straightforward ways to individuate these properties in terms of fundamental laws of nature. For instance, what specific property unit-negative ( $-e$ ) charge is, is spelled out by Maxwell's equations holding true of electric charges. Second, the fundamental dispositional properties, which are often called 'powers', are considered sufficient to determine the truth of the fundamental laws of nature. Thus, dispositional essentialism claims to bring with itself ontological economy: we need not

postulate such extra entities as laws or relations between universals, which would act as truthmakers of law statements.

In section one, we will outline the central features of our theory relevant to the present discussion. We will argue in section two that dispositional essentialism is incompatible with the Strong Nuclear Theory or Keith Campbell's and Douglas Ehring's trope theories because tropes would be identity-dependent on other tropes in dispositional essentialism. In addition to being incompatible with these one-category trope ontologies, dispositional essentialism faces serious problems in characterizing essences of fundamental properties. As we will argue in section three, the exact advantages of dispositional essentialism remain unclear in comparison with the views taking laws of nature as primitive. Finally, in section four, we outline an alternative account, based on Smith's (2016) non-recombinatorial quidditism, according to which tropes as particular characters or natures necessitate their own fundamental nomological roles. The resulting conception of powerful tropes is compatible with the Strong Nuclear Theory and does not introduce any such problematic additional constructions as primitive dispositional essences or laws of nature considered as fundamental constituents of reality. In our view, the closest substitutes for formal causes are powerful tropes necessary to a given substance.

## 2. The Strong Nuclear Theory Summarized

The trope bundle theories of substance (e.g. Williams 1953; Campbell 1981, 1990; Simons 1994; Maurin 2002; Keinänen 2011; Keinänen & Hakkarainen 2010, 2014; Giberman 2014; Fisher 2018) aim to construct objects and all other entities by means of aggregates of tropes. Tropes are thin particular characters or natures like a particular *-e* charge or a particular roundness. The nature with which each trope is identified is *what the trope is like*. In general, a nature may be essential, necessary or contingent to an entity. Therefore, the *concept* of nature here differs from the concept of essence—whether essence is understood modally or non-modally. Furthermore, tropes are themselves concrete in the sense of having some specific spatial or spatio-temporal location. In trope theories, objects and all other particulars are constructed as mereological sums of tropes that fulfil certain conditions. For instance, objects are identified with mereological sums of mutually co-located ('concurrent' or 'compresent') tropes (see Williams 1953; Campbell 1990). The thin nature of a trope is contrasted with the thick nature of the object constituted by distinct tropes.<sup>1</sup>

Most trope theories (i.e. trope-bundle theories) aspire to *analyse* monadic inherence (objects having tropes), e.g. by means of parthood, co-location and/or existential dependencies. Therefore, being a property (or, being an object) is not left primitive. In the trope theoretical analysis of inherence, a central feature of reality (objects having properties) is reduced to the holding of a fact about the basic entities of the category system (tropes). At the basic level, there are assumed to be only tropes that compose objects if the respective aggregate of tropes fulfils certain conditions.<sup>2</sup> Correspondingly, the object has a trope as its property if and only if the trope is a part of the object that fulfils an additional condition specified in a given trope theory—being co-located with the object, for instance.

As a simple example of a trope theory we may take Campbell's (1990) trope theory that identifies objects with mereological sums of co-located tropes. Assume that object *i* is a mereological sum of three mutually co-located tropes  $t_1$ ,  $t_2$  and  $t_3$ , which are determinate quantities. Let  $t_1$  be a determinate  $-e$  charge,  $t_2$  a determinate mass, and  $t_3$  a determinate spin quantum number. Object *i* has trope  $t_1$  as its property (i.e. *i* has a  $-e$  charge) if and only if *i* has trope  $t_1$  as its part and  $t_1$  is co-located with *i*.<sup>3</sup> Thus, in the trope theoretical analysis of inherence, the reduction is assumed to take place at the general level of ontological categories: the facts about objects and properties are assumed to be identified with the facts about tropes and the complex entities tropes compose.

Thus, in trope theories, the fundamental object–property dichotomy is explained away. Neither of these two categories—*objects* (entities characterized by properties) or *properties* (entities inhering in or characterizing objects)—retains its status as a fundamental category. Fundamentally, tropes are neither properties nor objects. Tropes are particular natures—entities of a single fundamental category—which constitute all (or almost all) other entities. Tropes are only conveniently identified (or picked out) as ‘properties of their bearers’ (such as the  $-e$  charge of an electron).

While Williams' and Campbell's classical trope theories take simple tropes as mutually independent existents, in our trope theory, Strong Nuclear Theory (Keinänen 2011; Keinänen & Hakkarainen 2010, 2014), tropes are assumed to be mutually existentially dependent beings. Objects are constituted as aggregates of tropes connected by the *formal ontological relations* of rigid and generic dependence.<sup>4</sup> Here, we confine ourselves to outlining the features of our theory directly relevant to the present discussion: for a more systematic presentation, see Keinänen (2011: sec. 4).

According to the Strong Nuclear Theory, every object has either a single nuclear trope or, alternatively, two or more tropes rigidly dependent on each other, the nuclear tropes.<sup>5</sup> Nuclear tropes are necessary parts of an object *i* and, intuitively, constitute its ‘necessary properties’. To be precise, trope *t* is a nuclear trope if and only if 1) *t* is not rigidly dependent on any other trope (a single nuclear trope), or 2) *t* is rigidly dependent on certain trope(s) which are also rigidly dependent on *t* (two or more nuclear tropes). Trope *t* is a part of object *i* if and only if *t* is rigidly dependent only on the nuclear tropes of *i*. Object *i* is a *dependence closure* of tropes with respect to rigid dependence. A dependence closure of tropes with respect to rigid dependence is a plurality of tropes in which all rigid dependencies of the tropes in the plurality are fulfilled. Moreover, we assume that necessarily, if these tropes exist, they form an individual. As a consequence, that individual is not rigidly dependent on any mereologically disjoint entity; see Keinänen (2011: 446–7).

Unlike the classical trope theories, the Strong Nuclear Theory does not build objects by means of co-location (‘compresence’ or ‘concurrence’), but uses relations of existential dependence. The second major difference between these trope theories concerns the determination of the location of individual tropes. In classical trope theories, individual tropes are relata of the basic spatio-temporal relations, whereas in the Strong Nuclear Theory, this function is given to certain trope bundles. According to the Strong Nuclear Theory, the two kinds of aggregates of tropes form individuals, which are minimal relata of the basic spatio-temporal relations: first, the nuclear tropes of every substance, and second, the nuclear tropes of a substance and every single trope contingent to a substance (if the substance has contingent tropes) (Keinänen 2011: 443).

The spatio-temporal locations of these complex entities determine the locations of their constituent tropes. In a simple case, object *i* is constituted solely by its nuclear tropes and the location of *i* determines the location of the tropes that are its proper parts. The Strong Nuclear Theory analyzes monadic inherence in this special case as follows: trope *t* is a property of object *i* if and only if, necessarily, if *t* exists, *t* is a proper part of *i* and *t* is co-located with *i*.<sup>6</sup>

Although assuming that tropes are mutually *existentially dependent* entities, the Strong Nuclear Theory agrees with Campbell (1990: 69) and Ehring (2011: 76) that (simple) tropes are *identity-independent* existents: their identity is not dependent on the identity of any other entity (Keinänen & Hakkarainen 2014). In other words, every trope has a fully determined identity, and this identity is primitive or ungrounded in every respect: it is a brute inexplicable fact that tropes are unities (as simples) that are distinct from each other and entities of other kinds, both synchronically,

diachronically and counterfactually. Since tropes are countable as unities—that is, they are countable in principle, which does not entail that we are actually able to count them in every case—it is fully determinate how many tropes there are in some location. Thus, the identity of tropes is not grounded in the identity of other tropes or entities of other kinds. Rather, the identities of entities of other kinds are grounded in the primitive identity of tropes. Tropes are the basic building blocks of the universe in the Strong Nuclear Theory: entities of other kinds are composed of them and their primitive identity determines the identity of these other entities.

According to the Strong Nuclear Theory, all simple substances (substances that do not have other substances as their proper parts) are trope bundles. As we have argued elsewhere (Keinänen & Hakkarainen 2014: sec. 3), it does not follow from the primitive identity of tropes that simple substances do not have determinate identity-conditions. Their identity-conditions are provided by tropes independently of substances, and these conditions are determinate. In the Strong Nuclear Theory, every simple substance has one or more tropes that are necessary to it and possibly tropes contingent on the existence of the substance. Nuclear tropes provide the identity-conditions for a simple substance both synchronically, diachronically and counterfactually: for instance, the simple substance persists as long as there are these nuclear tropes necessary to it (Keinänen & Hakkarainen 2010: 126).

Finally, one of the consequences of this view is that we disagree with those metaphysicians who individuate tropes by means of their spatiotemporal location (see Campbell 1981; Schaffer 2001). Schaffer (2001: 248–9), for instance, advocates the following spatiotemporal individuation principle:

**[SI]:**  $x$  and  $y$  are distinct tropes if they are either not exactly resembling, or at distant locations (Distance  $(x, y) > 0$ ).

We have two main reasons for disagreeing on the **[SI]**. First, the Strong Nuclear Theory allows for co-located simple substances such as co-located bosons, and also co-located exactly similar tropes, while the **[SI]** rules them out. Second, and independent of the Strong Nuclear Theory, it is hard to combine the **[SI]** with the claim that tropes are identity independent existents. Even if tropes are not individuated by space–time points (which would compromise their identity independence), it is difficult to individuate tropes by means of their spatio-temporal relations to *other* tropes while maintaining their identity independence.

Hence, we adopt what Schaffer (2001: 248) calls ‘the standard quantitative individuation principle’:

[QI]:  $x$  and  $y$  are distinct tropes iff they are primitively quantitatively distinct.

### **3. The Strong Nuclear Theory is Incompatible with Dispositional Essentialism**

It is precisely because of the identity-independence of tropes that our theory is incompatible with dispositional essentialism. The latter is committed to the view that there are identity-dependent basic physical properties, and—if considered in the trope theoretical framework in which ‘instances’ of basic physical properties are tropes—to the view that there are identity-dependent tropes.

According to the most recent expositions of dispositional essentialism, there are basic physical properties that are individuated by their place in a causal, dispositional, or nomological structure of powers and the stimulus and manifestation properties of the powers. In other words, this individuation is done by the causal, dispositional or nomological role or profile of these basic physical properties (Yates 2013: 93; Smith 2014: 250; Bird 2016: 345; Yates 2016: 143; Yates 2018). Consider such a basic physical property as a power. Its typical illustration is charge. Tentatively, charge is at least partly the property of repelling spatio-temporally related like charges. Bird, for example, thinks that the identity of basic physical power properties is metaphysically determined or given by their causal, dispositional or nomological roles; or, to be more precise, by their position in a network of the second-order Stimulus-Response (‘SR’, for short) relations of a disposition, its stimulus and manifestation conditions (Bird 2007: 145–6; Bird 2016: 345). These stimulus and manifestation conditions may or may not be or involve powers. Dispositional essentialism as such is not committed to Pure Powers Ontology, according to which each basic physical property is a power, but only that some are: dispositional essentialism is compatible with the view that some basic physical properties are not powers (Barker 2013: 622; Yates 2018). Here we consider dispositional essentialism as this weaker view in order to make our reasons for not holding it stronger. Even this weaker dispositional essentialism is an essentialist position since that which individuates an entity, that is, a causal, dispositional, or nomological role in dispositional essentialism, is essential to the entity. As Giannini & Mumford argue elsewhere in this collection, dispositional essentialism is also a specific variety of the doctrine of formal causation since powers are formal causes grounding certain kind of formal explanations.

A consequence of utmost importance here is that there are basic physical properties, namely powers, that are identity-dependent in dispositional essentialism. Informally, *which* basic physical property some power is, is metaphysically determined by its causal, dispositional, or nomological role or profile: its position in a network of SR relations in Bird's view. Since this role or position necessarily involves a relation to some stimulus and manifestation properties, these other properties have to be involved in determining which basic physical property the power is. The power depends at least partly for its identity on the stimulus and manifestation properties. In the case of charge, these stimulus properties are charge and distance, whereas force is a manifestation property in accordance with Coulomb's law (Yates 2013: 104).

More precisely, dispositional essentialism states that powers are individuated by their places in a type-causal, dispositional or nomological structure fully composed of physical properties and the primitive stimulus and manifestation *relations* between them (Yates 2018 argues that this structure involves non-basic physical properties in his view). So powers are fully individuated by the primitive stimulus and manifestation relations holding between them and other physical properties. This satisfies the definition of identity-dependence. If Tuomas Tahko and E. J. Lowe's definition is put in terms of individuation rather than non-modal essence (not to assume non-modal essentialism)<sup>7</sup>, it goes as follows:

[ID]:  $x$  depends for its identity upon  $y$  =<sub>df</sub> There holds a relation  $F$  such that it is part of the state of affairs which entity  $x$  is that  $x$  is related by  $F$  to  $y$  (see Tahko & Lowe 2019).

In dispositional essentialism, it is part of the individuation of powers that they are related by some primitive stimulus and manifestation relation to some other physical property, because powers are fully individuated by the structure consisting of these relations. Now, according to dispositional essentialism, powers are basic physical properties. Thus, dispositional essentialism is committed to the view that there are identity-dependent basic physical properties.<sup>8</sup>

In Campbell's, Ehring's, and our trope theory, this will not do. In contrast to dispositional essentialism, no basic physical quantity or property is identity-dependent. We think that tropes are basic physical quantities and their pluralities serve as basic physical properties (Keinänen, Hakkarainen & Keskinen 2018). We have compelling reasons for holding that tropes are identity-independent entities. These reasons have to do with Lowe's *reductio ad absurdum* argument against trope theory. Lowe's *reductio ad absurdum* argument forms the first horn of his dilemma against trope theory (Lowe 1998: 206).<sup>9</sup> Our formulation of it is the following:

[P1]: According to trope theories, objects (or substances)<sup>10</sup> are bundles of tropes. Tropes are parts of an object; they are the entities composing the object.

[P2]: According to the best trope theories, tropes are identity-dependent on their bearers, that is, objects.

[P3]: If objects are trope bundles, they are identity-dependent on some of their trope parts.

[P4]: Identity-dependence is asymmetric: if  $e$  and  $f$  are distinct entities and  $e$  is identity-dependent on  $f$ ,  $f$  cannot be identity-dependent on  $e$ .

[C1]: Thus, an object both depends for its identity on some of the tropes composing it and all the tropes composing the object are identity-dependent on it (by [P2] and [P3]).

[C2]: This contradicts [P4]: the asymmetry of identity-dependence.

We think that the only way to save the Strong Nuclear Theory from this contradiction is to deny the premise [P2]: tropes are *not* identity-dependent on their bearers. We can see it by considering the other premises briefly. It is not possible for us to reject [P1] about the composition of simple objects. The notion of identity-dependence applies to simple objects in relation to their nuclear tropes, even though we do not employ the notion in our formulation of the Strong Nuclear Theory. The nuclear tropes metaphysically determine which simple substance an object is diachronically, synchronically, and counter-factually. Therefore, we cannot deny [P3], and Lowe is right that identity-dependence is asymmetric [P4]. Furthermore, let us make the plausible assumption that identity-dependence is transitive. Then, if a nuclear trope was identity-dependent on the simple substance in which it inheres, the nuclear trope would depend for its identity on each nuclear trope of the same substance (*mutatis mutandis* for the contingent tropes). The same conclusion would hold for any nuclear trope. The consequence would be that the nuclear tropes of a simple substance are mutually identity-dependent, which would contradict the asymmetry of identity-dependence. Hence, the only way out for us is to reject [P2]: to state that no trope depends for its identity on any substance, other trope, or indeed any entity. According to the Strong Nuclear Theory (as well as in Campbell's and Ehring's trope theories), tropes are identity-independent entities, as we argued in the previous section.

In terms of the discussion of dispositional essentialism, powers and laws of nature, the Strong Nuclear Theory is a quidditist theory: basic physical quantity tropes have primitive identity also across metaphysically possible worlds. In the final section, we propose somewhat tentatively that the precise form of quidditism here is what Deborah C. Smith calls *Moderately austere quidditism*. We do not argue that moderately austere quidditism is superior to the competing views such as dispositional essentialism. We just point out that when our trope theory is wedded with moderately austere quidditism, we are not worse off than dispositional essentialism with respect to powers and



laws of nature. Besides, in the next section we argue that there are reasons independent from the details of the Strong Nuclear Theory for not subscribing to dispositional essentialism.

## 4. Additional Reasons not to Endorse Dispositional Essentialism

As was seen above, properties endowed with dispositional essences (powers) are supposed to do a considerable amount of metaphysical work. On the one hand, laws of nature necessary to a power provide empirically detectable identity conditions for powers. For instance, Maxwell's equations are assumed to determine what specific property  $-e$  charge is (the same of course holds of other determinate charges). On the other hand, fundamental powers are themselves assumed to act as truthmakers of certain fundamental laws of nature. For example, the property of  $-e$  charge makes Coulomb's law concerning the very same property true (see Mumford 2004). There are some general difficulties concerning this truth-making claim: since laws of nature are assumed to be *universal* statements about the behaviour of objects, it is not clear whether law statements have *any* truthmakers. Nevertheless, we can express the same intuition in terms of supervenience: since the truth of law statements supervenes on the existence of certain powers, there is no need to postulate such additional entities as laws—considered as relations between universals, for instance—to determine the truth of the corresponding law statement. Powers are sufficient to determine the truth of these laws (Yates 2013: 98). A trope theorist can welcome this move as the supervenience base might be considered to consist of certain kinds of tropes. As we have argued elsewhere (Keinänen, Keskinen, & Hakkarainen 2019), quantity tropes fall under determinates (e.g.  $-e$  charge) and determinables (charge) because of being related by different relations of proportion and the relation of order. The latter are internal relations, which hold because of tropes being the quantitative natures that they are.

Unfortunately, there are deeper difficulties pertaining to powers (or dispositional properties) allegedly satisfying these claims. Dispositional essences of properties allow for different, mutually incompatible characterizations. Some of them seem to entail that relations (considered as relational entities) between properties occur in the constitution of dispositional essences. According to Bird (2007: 64), the essence of a power 'is a dispositional relation between stimulus property and manifestation property'. The essence of a power is typically assumed to be constituted by many such

dispositional relations (or, SR-relations) between different properties. According to Bird (2007: 139), these essences literally have a relational constitution: SR-relations are second-order relations between properties.

This view is somewhat disturbing and raises further questions. Assume that the essence of a fundamental monadic dispositional property (power) has a relational constitution, namely that it is constituted by a second-order relation holding between its stimulus properties and its manifestation properties. One may ask: are these second-order relations somehow involved in the constitution of powers?<sup>11</sup> Are such second-order relations additional entities, which have an irreducible determination role?<sup>12</sup> To avoid these specific issues, a dispositionalist may take the relational constitution of the essences of properties in a more abstract way. Dispositionalists may assume that essences are abstract entities, such as propositions accompanying powers, which contain a reference to SR-relations.<sup>13</sup> If we adopt this propositional characterization of dispositional essences, we perhaps avoid the postulation of additional second-order relations. But again, the dispositionalist has put the desired characteristics of powers to their essences, namely, that certain SR-conditionals hold true of the instantiations of the same properties.

What one can learn from the most explicit formulations of dispositionalism (such as Yates 2013) is that the instantiation of a fundamental power (such as a determinate electric charge) is necessarily equivalent to the holding of a group of infinitely many SR-conditionals. On that basis, we can infer that a law of nature, such as Coulomb's law in the case of determinate electric charge, necessarily holds true of a power (see Yates 2013: 102–5). According to an alternative approach, we can begin with the fundamental laws of nature about the fundamental properties such as electric charges and masses, and take these laws essential to these properties. Depending on which laws are considered essential to a power (such as  $-e$  charge), we may or may not arrive at a characterization of a dispositional essence of a property, which is extensionally equivalent to the previous approach.<sup>14</sup> In any case, it seems that the 'dispositional essence' of a fundamental property can be fully characterized by a certain set of relevant fundamental laws holding true of that property.

Hence, it remains questionable whether dispositionalists gain any ontological economy in comparison with the views taking laws of nature or modal conditionals as primitive.<sup>15</sup> Rather, dispositionalists pack enough desired characteristics into the essences of dispositional properties that they suffice to determine the truth of the relevant laws. As defenders of an economical one-category

ontology, trope theorists strive to avoid both postulating such general entities as laws and construing the same generalities as essences of properties.

## 5. A Sketch of an Alternative Account

We finished section two by stating that our tentative suggestion is to hold *Moderately austere quidditism*. When we distinguish it and quidditism in general from dispositional essentialism, we have to be extra careful. There are forms of both that come quite close to each other, but are distinct positions with widely different consequences and views about the nature of basic physical properties. With this respect, Smith's 2016 paper is helpful. First of all, following Dustin Locke (2012: 351), she distinguishes *Extravagant quidditism*—in which 'properties are individuated by their quiddities'—from *Austere quidditism*—in which 'properties are individuated by numerical identity' (Smith 2016: 241). Quiddities are the intrinsic natures of properties (Smith 2016: 238). Then Smith argues that the latter divides into an *Extreme* and *Moderate* type depending on whether there is anything truly qualitative in basic properties. Extremely austere quidditism denies it, whereas Moderately austere quidditism holds that basic properties are 'qualitatively distinct though their [numerical] identity and distinctness is simple and unanalysable.' (Smith 2016: 244, 250) According to moderately austere quidditism, charge and rest mass, for instance, are simple different qualitative natures and their individuation is a brute fact. It is just an inexplicable fact that charge and rest mass are numerically distinct properties. In this context, 'qualitative' means 'suchness' or what entities are like rather than the opposite of 'quantitative': quantities are also qualitative in this broader sense (Smith 2016: 238).

Smith (2016) assumes realism about universals. As we are trope theorists, we begin with distinct particular natures, that is, tropes. We hold that tropes of the distinct highest determinables, such as charge and rest mass, are *qualitatively* distinct, that is, fall into distinct determinates (for instance, negative unit charge) because of being related by different relations of proportion and order (Keinänen, Hakkarainen, & Keskinen 2018: secs. 2-3). The relations of proportion and order are basic internal relations, which hold because of tropes being the quantitative natures they are (Keinänen, Keskinen, & Hakkarainen 2019: sec. 3). Moreover, *numerical* identity and distinctness of tropes are primitive or brute facts—whether intra- or transworld. To repeat, unlike in dispositional

essentialism, no trope is individuated by a causal, dispositional, or nomological role (or something similar).

How do tropes relate to causation, dispositionality and laws of nature then? According to Smith (2016: 250), moderately austere quidditism can be wedded with the view that ‘the qualitative differences between distinct fundamental properties restrict the ways their instance can be recombined in space and time.’ Then we get what she calls ‘non-recombinatorial quidditism’. On this view, basic properties metaphysically necessitate their nomological roles at least in part. Charge, for instance, necessitates the nomological role it plays in Coulomb’s law as a matter of metaphysical necessity. When these roles are metaphysically necessary to basic properties, they are ‘fundamental roles’. Fundamental roles do not have to exhaust the nomological roles that a basic property plays. A non-recombinatorial quidditist can allow for the underdetermination of the nomological roles of a basic property by its fundamental role(s) (see Smith 2016: 251). Since properties ‘*are* intrinsic natures’ in moderately austere quidditism, non-recombinatorial quidditism holds that basic intrinsic natures necessitate their fundamental nomological roles as a matter of metaphysical necessity (Smith 2016: 244, 250).

In the Strong Nuclear Theory, tropes are identified with intrinsic basic quantitative natures. Non-recombinatorial quidditism and moderately austere quidditism therefore fit well with the Strong Nuclear Theory: tropes metaphysically necessitate their fundamental nomological roles. The difference to Smith’s realist picture is that in contrast to universals, the principle of the identity of indiscernibles does not hold true of tropes. Let us first concentrate on qualitatively identical tropes for the sake of simplicity of the exposition. They are numerically distinct, whereas instances of a property universal are instances of the same entity. However, as John Heil (2012: 99–100) points out, the difference between qualitative and numerical identity does not matter so much theoretically here. If we are talking about qualitatively identical tropes falling under a lowest determinate, each of them metaphysically necessitates the same fundamental nomological roles. For instance, one might think that each  $-e$  trope metaphysically necessitates the nomological role it plays in Coulomb’s law.<sup>16</sup> So we can take any  $-e$  trope and it plays the same fundamental nomological role as a matter of metaphysical necessity. In other words, this nomological role is metaphysically necessary to the trope.

If we consider qualitatively *distinct* tropes, realism is in a subordinate position to the Strong Nuclear Theory unless the realist is ready to postulate *determinable* universals. Instances of the same

determinable are *not* instances of the numerically identical determinate in each case. Therefore, the realist that is ontologically committed only to determinate property universals cannot say that a determinable basic physical property entity necessitates a fundamental nomological role. By contrast, we have an account of tropes falling under the same highest determinable such as charge, which gives us theoretical grounds to say that *any* charge trope plays the same fundamental nomological roles (Keinänen, Hakkarainen, & Keskinen 2018). However, this does not have the consequence that charge tropes play these roles and are hence dispositional in that sense in virtue of being of the determinable kind ‘charge’. Rather, as was seen in the previous section, these tropes are charge tropes because of the natures with which they are identified. We reject the existence of kinds of tropes altogether (ibid.). Therefore, since on our view tropes do not play their nomological roles in virtue of their kinds, our view is not in this sense a type of formal causation either.

By Keinänen’s (2018) account of relational tropes, or more precisely r-tropes, we can generalise this beyond non-relational tropes (e.g. charges and rest masses). The rough idea is to consider forces and distances, for instance, as r-tropes. They are also identified with certain basic quantitative natures, which metaphysically necessitate the fundamental nomological roles in the same manner *mutatis mutandis* as we outlined about non-relational tropes just above.

Tropes are powers only in this derivative sense. They are identified with basic quantitative natures that metaphysically necessitate which fundamental roles the tropes occupy.<sup>17</sup> Consequently, tropes are not powers irreducibly, which would make them formal causes grounding some formal explanations if Giannini & Mumford are right. Our Strong Nuclear Theory is not a formal causation view in this dispositionally essentialist sense. In contrast to what Yates (2018) says about Smith’s view, our proposal is not a *powerful qualities* view either (e.g. Heil 2012, sec. 6; Taylor 2018; Giannotti 2019). Unlike powerful qualities, tropes are not identical to or involve non-derivative powers.

As was seen in the first section, we defend an account of non-relational tropes inhering in simple substances: trope *t* is a property of simple substance *i* if and only if, necessarily, if *t* exists, *t* is a proper part of *i* and *t* is co-located with *i*.<sup>18</sup> Therefore, we can say that tropes confer powers onto simple substances in the sense that they derivatively inhere in the same objects, and that the natures tropes are metaphysically necessitate fundamental nomological roles. So it is in virtue of bearing these natures (i.e. having these tropes as their necessary or contingent properties), rather than

because of the kinds of tropes or substances or the fundamental nomological roles of the tropes, that simple substances can be said to be powerful particulars.

Laws of nature do not therefore *govern*: they do not metaphysically determine what happens in the world. On the contrary, they *describe, summarise or descriptively codify* the properties and behaviour of entities underwritten by tropes (Demarest 2015: 335; Kimpton-Nye 2017: 134).<sup>19</sup> Coulomb's law, for instance, describes the quantity of electrostatic force between two stationary electrically charged particles. It is a mathematical representation of the ratio between the quantities of the charges of the stationary particles and their distance multiplied by Coulomb's constant. This ratio is the quantity of electrostatic force between the charged particles, which is observable as their attracting or repelling behavior in the closed two-particle physical systems. In our trope theory, this force, the charges and the distance of the particles are construed as tropes playing the nomological roles they play in Coulomb's law. The electrically charged particles do not experience the electrostatic force in virtue of Coulomb's law. Rather, the law describes the force given the quantities of the charges and the distance between the particles. Other laws describe the following changes in the momenta of the particles in the closed system. Laws of nature are neither entities nor essences of entities.

In principle, laws of nature may be asserted by true law statements. The truth of law statements may be considered to supervene on different kinds of tropes. In some cases, the truth of a specific law (e.g. Coulomb's law) might be considered to be determined by the tropes falling under certain determinables (e.g. charge and distance tropes). However, there are general laws like conservation laws, whose truth might be determined by larger physical systems. In principle, our account of laws is similar to the one we suggested for dispositionalists in section three. Nevertheless, our bottom-up trope theoretical conception does not introduce any general law-makers.<sup>20</sup> Similarly, nomological roles are rather representations than distinct entities in themselves. They do not exist since there are no laws of nature. We have only law statements that specify what nomological roles represent in relation to each other (e.g. Coulomb's law as described just above). As an analogue, one can play the role of Hamlet specified by the play *Hamlet* without the character of Prince Hamlet existing. People merely represent to themselves that such a character exists.

We do not see any principled obstacle for other trope theories than ours to adopt non-recombinational quidditism. One interesting way to further develop it is to take tropes as proper parts of causal processes, which are themselves complex particulars. Following Ellis (2001) and

Handfield (2008), we may assume that these processes subdivide into different natural kinds. For instance, a physical system of two repelling electrons constitutes a process belonging to a natural kind. We may assume for the sake of argument—and ignoring the physical details—that in a system of repelling electrons, there are two  $-e$  charge tropes, which are parts of particles connected by certain r-tropes of spatial distance. These particles connected by r-tropes form an r-complex (relational complex). The r-complex is not a static continuant, but a part of a series of different kinds of r-complexes. Because the r-complex is generically dependent on certain kinds of additional r-tropes, connecting its parts, for instance r-tropes of electric repulsion or gauge boson exchange, the parts of the r-complex may be said to experience electric forces which alter their state of motion and relative positions.

The present development of our approach does not eliminate the need for law statements in the description of the interacting physical particles. But it provides a clear answer to the worries of *ad hocness* against non-recombinatorial quidditism (see e.g. Jaag 2014: 16). In the present approach, we are not confined to stipulating necessary relations between tropes and the truth of certain laws—that certain kinds of tropes contribute to determining the truth of certain law statements. Rather, tropes are generically existentially dependent parts of certain kinds of causal processes—considered above as groups of r-complexes—which are described by laws. It remains to be a matter of further study of the details of every specific process how the truth of the respective law statement (such as Coulomb’s law) is determined.

To take another objection, Yates’ only argument against moderately austere quidditism and non-recombinatorial quidditism is what Smith herself (2016: 251) acknowledges: ‘nothing in non-recombinatorial quidditism precludes different basic physical properties having the same nomic roles.’<sup>21</sup> He also notes that ‘nothing precludes possible worlds with the same nomic structure as actuality but a different totality of powerful qualities occupying the basic physical roles, so related in virtue of being the qualities they are.’ (Yates 2018, 4534–5)

We are not sure if these scenarios are metaphysically possible. The first scenario of shared nomological roles might be ruled out by providing a more detailed account of physical processes and events in which a certain kind of property can be involved—for instance in the manner outlined above. The second scenario, if applicable to our account, concerns actual nomological roles occupied by some alien tropes. Since it is impossible to have any empirical access to alien tropes, it is very difficult to make principled judgements about them. In any case, these scenarios concern epistemic

identification rather than metaphysical individuation. Any metaphysically realist ontology has to admit the possibility that some features of the world are in principle inaccessible to us. So we are not epistemically worse off than other metaphysically realist positions, Yates' dispositional essentialism included. Moreover, our account is not subject to the permutation problem that the nomological roles that properties play in the actual world are swapped in some non-actual possible world (Yates 2013: 96). Fundamental nomological roles cannot be swapped freely because they are metaphysically necessitated by the natures with which tropes are identified.

## 6. Conclusion

In this chapter, we have argued that dispositional essentialism is incompatible with our qualitatively economical trope bundle theory (Strong Nuclear Theory) and any trope theory committed to the primitive individuation of tropes. As we argue in section two, dispositional essentialism would render at least some tropes identity-dependent on other tropes, while *all* tropes must be considered as identity-independent existents in the Strong Nuclear Theory (like in Campbell's and Ehring's trope theories). Second, in section three, we provided independent reasons to remain critical to dispositional essentialism. The main problem with dispositional essentialism is that it builds the holding of the relevant laws of nature into the essences of basic dispositional properties (powers). Therefore, it remains unclear whether dispositional essentialism gains any ontological economy in comparison with the views taking laws of nature as primitive. Finally, in section four, we outlined an alternative view based on Deborah Smith's (2016) non-recombinational quidditism. According to it, tropes as determinate particular natures necessarily play certain fundamental nomological roles. Moreover, we argued that non-recombinational quidditism can be combined with a new conception of tropes as parts of causal processes, which further clarifies the necessary connection between tropes and certain nomological roles. All this has the consequence that our trope theory does not represent a specific variety of formal causation that dispositional essentialism, as it is nowadays understood, involves.<sup>22</sup>



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<sup>1</sup> In Williams' (1953, 2018) and Campbell's (1990) classical trope theories, tropes are also considered as 'abstract' in the sense of having capability of being co-located with other tropes, Fisher (2018: sec.1).

<sup>2</sup> According to Williams (1953), tropes are existentially independent entities and objects are mereological sums of co-located (compresent, concurrent) tropes; see Fisher (2018) for further discussion.

<sup>3</sup> Since Campbell (1990: secs.4.3–4.4) constructs complex quantity tropes as 'conjunctive compresences' of simpler tropes falling under the same determinable, an additional maximality

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condition would need to be added to the analysis in order to deal with such mutually co-located tropes forming a complex trope.

<sup>4</sup> Let ' $\leq$ ' be a relation of improper parthood and 'E!' the predicate of existence. Entity  $e$  is strongly rigidly dependent on entity  $f$ , if the following condition holds:  $\neg(\Box E!f) \ \& \ \Box ((E!e \rightarrow E!f) \ \& \ \neg(f \leq e))$ ; see Simons (1987: 112, 294ff.).

<sup>5</sup> The applicability of the notion of rigid dependence is restricted to contingent existents. Moreover, trope theorists can reject the existence of sets (as entities outside space and time) on which objects would (allegedly) be rigidly dependent.

<sup>6</sup> Keinänen (2011: 438–40). The more general condition, which also deals with the tropes contingent to an object, is temporally qualified: necessarily, trope  $t$  is co-located with  $i$  when it exists (Keinänen 2011: 440ff.).

<sup>7</sup> For non-modal or (Neo-)Aristotelian essentialism, see Fine (1994, 1995) and Lowe (2012).

<sup>8</sup> This argument is inspired Lowe's (2010) argument against the Pure Powers Ontology.

<sup>9</sup> For our full answer to Lowe's dilemma, see Keinänen & Hakkarainen (2014: 68–75).

<sup>10</sup> Below, we speak of 'objects' and 'substances' interchangeably.

<sup>11</sup> Barker (2013: sec.4.1) seems to give an affirmative answer to this question: powers are (at least partially) constituted by second-order relations.

<sup>12</sup> Barker (2013: sec, 4) argues that the second-order SR-relations constrain or govern the behaviour of objects instantiating powers. Similarly, Yates (2016) argues that a dispositionalist must introduce irreducible type-level causal-relations, which individuate powers.

<sup>13</sup> Here, essences of powers would be their real definitions containing reference to SR-relations; see Fine (1994, 1995) for such an account of essences.

<sup>14</sup> Yates (2013) argues that only certain laws which are necessitated by the instantiation of a power (such as an electric charge) are essential to that property.

<sup>15</sup> Laws of nature are taken as primitive constituents of reality by Maudlin (2007: ch.1) and French (2014). According to Lange (2009), subjunctive facts are primitive denizens of reality instead of laws.

<sup>16</sup> Note that the present account is not, unlike Bird's (2007) dispositional essentialism, committed to the view that, necessarily, certain laws of nature hold true if certain basic physical properties exist. The question about the modal status of specific laws would require further discussion.

<sup>17</sup> Recall that here the notion of nature differs from the notion of essence in any sense.

<sup>18</sup> Recall that this is a special case of objects having only nuclear tropes (tropes necessary to the objects).

<sup>19</sup> This does not involve any commitment to the reality of causation regarding the domain of fundamental physics.

<sup>20</sup> It must be acknowledged that the centrality of certain very general laws—like symmetry principles and conservation laws in physics has motivated structuralist ontologies (like French 2014) and other accounts reifying the general facts allegedly described by these laws (e.g. Lange 2009). However, providing a bottom-up trope theoretical account of such laws must be left for another occasion.

<sup>21</sup> Earlier, Yates (2013: 96) calls this the 'duplication' problem.

<sup>22</sup> We would like to thank Emil Aaltonen foundation and Kone foundation for financially supporting this research.