Tendencies and other Realizables
in Medical Information Sciences[1]

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1   Introduction

1.1   Why Tendencies are Important for Medical Information Sciences

It would sound a bit odd if a medical scientist were to describe his work as research on certain special sorts of entities called "tendencies". Nevertheless, searching the standard Medline database of medical research literature yields 48,884 hits for the word "tendency" together with an additional 4720 hits for its plural. This is quite something, especially if one takes into account also the figures for related terms such as "disposition" (20,991 hits) and "propensity" (9639 hits).[2] The entities described as tendencies play an important role in medical terminologies under the heading of *medical findings*. Such findings are, for example, a psychopathic tendency, a suicidal tendency, the tendency to bleed or the thrombophilic tendency. Many medications are designed to prevent the realization of tendencies. A patient "with suicidal tendency" will be treated in such a way that suicide events will be less likely to occur.[3]

In the light of these facts, it is quite astonishing how little information can be found about tendencies in the major medical terminologies such as the *National Cancer Institute Thesaurus* (NCIT) or the *Unified Medical Language System* (UMLS).[4] The UMLS Metathesaurus comprehends some 5 million terms from more than 100 different controlled terminologies and biomedical classifications. Among these terms are such items as "entity", "event", "property", "mental process" or "value", not however "tendency", though the latter term does appear in 23 places within more complex terms that are included (such as *Tendency to nausea and vomiting*) or within definitions (as in "tendency of a drug, with repeated use, to become less effective […]", one of the definitions given for *Drug Tolerance*).[5] The NCIT, too, lacks an entry *Tendency*. It does, however, contain an entry *Disposition*, which is defined as follows:

> Disposition—the tendency of something to act in a certain manner under given circumstances resulting from natural constitution; nature; quality; orderly arrangement.

It is not clear what the semicolons are intended to signify in this definition. The terms that are enlisted with semicolons between them do not seem to be synonymous: a nature is distinct from a quality, and both are distinct from an orderly arrangement. Thus, contrary to the official intention of the NCIT,[6] the term "disposition" in the NCIT seems not to signify a unique thing, but rather a somewhat confused bundle of things. Moreover, the NCIT subsumes *Disposition* under the heading *Conceptual Entity* and not, as one would expect, under the heading *Property or Attribute*. Surprisingly again, NCIT contains no sub-items of *Disposition*, though it seems to be obvious that all tendencies "to act in a certain manner under given circumstances resulting from natural constitution" (for example, *Tumorigenicity* or *Lipophilicity*) should be listed as sub-items here.

Given the widespread occurrence of words like "tendency" and "disposition" in the medical literature it would be very desirable for the terminologies to reflect this importance by adequately representing these subtypes. This is because one of the most important uses of such terminologies is the annotation of research literature in order to enhance information retrieval. Also, the truth of statements like *Tumorigenicity is-a Tendency* should be reflected in subsumption relations between the corresponding terms in order to enhance automated reasoning.

1.2 Previous Work

Like dispositions, tendencies are causal properties. Standard accounts characterise a tendency as "an entity which can be counteracted by other tendencies" or as "a potentiality which may be exercised without being realized".[7] The first of these characterisations being circular and the second introducing three new undefined terms, these definitions are insufficiently rigorous for the purposes of information systems which are designed to support computational reasoning. Thus we have to go further. While discussion of tendencies can be traced back at least to Aristotle and to what he says on *dynamis*, *physis*, and *hexis*,[8] there is comparatively little discussion of tendencies in the recent philosophical literature.[9] An exception is the work

of Daniel von Wachter, who has argued that the ontology of tendencies may help in ontological engineering.[10] Von Wachter defines a tendency as "a bias in the world at a certain time to carry on in a certain way" (p. 111). His account of tendencies, however, gives rise to the following three problems.

a. Who or what is the bearer of tendencies? In von Wachter's eyes, it is a state of affairs which is the bearer of a tendency. States of affairs are, in a nutshell, all those complex entities that can be described in that-clauses. Examples are the state of affairs that patient #0004 has red hair or that patient #0012 is slightly green in the face. By ascribing tendencies to complex entities like states of affairs one gains purchase on the *circumstances necessary for a certain outcome*. Often, over and above the presence of a certain tendency, other necessary conditions have to be fulfilled to trigger the realization process. Such conditions should not be neglected. But in medicine, tendencies are often ascribed not to states of affairs, but to patients, i.e. to concrete things, independent continuants existing in time and space. It is the patient, not some state of affairs, who has the suicidal tendency or the tendency to bleed. And it is patients, and not states of affairs, who need to be healed. Here I join with those ontologists who distinguish between forces and tendencies: forces are always related to some body they act on, thus they are something relational; tendencies, in contrast, are properties of single concrete things. According to this picture, forces are not themselves tendencies, but they bring about tendencies in the things they act upon.[11]

b. Causality and Tendency Bases. von Wachter's goal is to answer "the ontological question about causation": what is it in reality that makes causal statements true? (p. 113). His answer is that "A caused B if and only if A was the basis of a tendency towards B and the tendency was realized" (p. 113). The *basis* of a tendency is the "state of affairs at t_1 that is relevant for the obtaining of the tendency" (pp. 112-3). But how do basis and tendency relate? Are they identical? Does the basis A constitute the tendency? Is the basis itself a cause of the tendency? And why is the tendency important at all, if it is the basis A which causes the event B?

c. Are all monopolised tendencies realized? von Wachter claims that a tendency "will be realized if and only if there is no counteracting tendency" (p. 112). A stone will fall towards

the surface of the earth, if and only if nothing holds it back. But this principle is in fact highly problematic. First, the absence of counteracting tendencies is not necessary for a realization. Imagine a Ferrari being acted upon by three forces that bring about three different tendencies of the car:
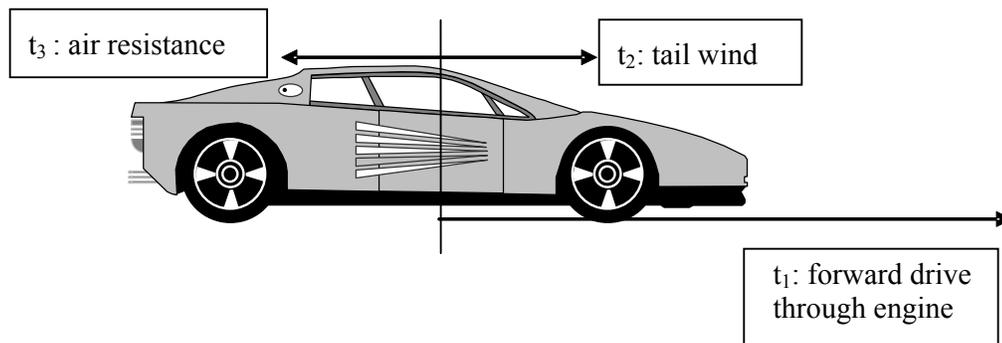
This Ferrari has a tendency t_1 to drive forward as a result of the fact that its engine is running; it has a considerably weaker tendency t_2 to drive forward as a result of the actions of a tail wind; and a third, similarly weak, tendency t_3 not to move forward as a result of air resistance. Now imagine that the forces that bring about t_2 and t_3 are of equal size. Then t_1 will under these circumstances be realized as if it were the only tendency present, although in fact there is a counteracting tendency t_3. Thus the absence of counteracting tendencies is not necessary for a tendency to be realized.

Second, the absence of counteracting tendencies is also not sufficient for the realization of a tendency. This can be seen in indeterministic theories like quantum mechanics. An atom has the tendency to decay with a certain probability within a certain time. But because of the probabilistic character of this tendency, even if it were the only tendency present in a given situation, there is no guarantee that it will be realized.

1.3 Tendencies in Science

Having used examples from classical physics and quantum mechanics, I should add two remarks on tendencies in different sciences. First, within classical dynamics tendencies are additive as a result of the fact that all tendencies are brought about by forces that are measured

by the same physical unit (the Newton), and can be represented as vectors that can easily be added to other vectors. Because of the mathematical properties of vectors, all tendencies combine to yield a single, determinate result. Such a straightforward addition of tendencies is not possible in all cases. Suppose a petunia has the tendency to flourish when placed in a sunny place and the tendency to starve when given too much water; which tendency does it have when placed in a sunny place with a surfeit of water?[12] Or consider human agents, who are acted upon by very different (social, psychological, genetic) forces or influences which normally do not come with any affixed number and unit of measure. This makes it more difficult on the theoretical plane to combine several single tendencies into any single result.

Second, classical dynamics is a deterministic theory. When tendencies have determinate results, our theories can in effect ignore the realm of tendencies and focus exclusively on actual happenings. In this, they differ from indeterministic theories like quantum mechanics and from theories, for example in the humanities, that take into account factors such as free will and spontaneous action. In indeterministic theories, the resultant tendency in no way amounts to a guarantee of one and only one consequent happening: our theories apply always within a realm of probabilities, and we have to wait to find out what will actually happen. Many tendencies in the medical domain are of this latter kind.

2 Tendencies and their Realizations

2.1 Realizables: A General Structure

Tendencies are properties of a special kind in that they point forward to something—their realization—that they enable or cause or make probable. If a patient has a tendency to bleed, bleeding is the realization of this tendency. Thus the realization is distinct from the tendency itself. While the tendency to bleed is a property of the patient, bleeding is a process or activity. The realization of a tendency is thus not the same as the existence of a tendency. Tendencies can exist without being realized. A patient can have a tendency to bleed even at a time when he is not bleeding. I will call all properties that share this structure "realizables". Realizables have the following features: (1) They are properties, and like all properties they are ontologically dependent on their bearer. (2) They are related to other entities—called

"realizations"—which they cause, enable or make probable. (3) They can exist independently of their realization.

2.2 Different Kinds of Realizables

There is a whole variety of realizables other than tendencies, including dispositions, propensities, abilities, potentialities, and virtues, some of which have a long history in philosophical debates.

a. Dispositions. The major part of the recent philosophical study of dispositions[13] has centred on 'sure-fire' dispositions, i.e. on dispositions that invariably lead to a certain result given certain circumstances. Thus, an ascription of a disposition is usually of the form "x has the disposition D to become R given circumstances C", as for example in:

(D1)   Sugar has the disposition to dissolve when placed in water.

(D2)   This glass has the disposition to break when thrown on the floor.

It is often said that dispositions are "occult powers" because one can never "observe" a disposition itself but only its realization. In fact, however, a disposition ascription of the above form entails a test procedure for any given disposition D: Put x in circumstances C and watch whether x becomes R.[14]

b. Propensities. While 'sure-fire' dispositions are dispositions that invariably lead to a certain result given certain circumstances, propensities do so only with a certain probability.[15] They are therefore sometimes also called 'probabilistic dispositions'.[16]

c. Abilities. Abilities differ from dispositions in very important respects: First, while dispositions can be ascribed to just about anything that can be a bearer of properties (i.e. to all substances), an ability is normally ascribed only to a person or an agent. Second, while dispositions are invariably realized in certain circumstances, the realization of an ability may depend on its bearer's decision. The realizations of abilities are actions. Thus, with abilities we enter what some think of as the sphere of free will. Third: When we talk about abilities,

we often mean not only the ability to do something *simpliciter* but also the ability to do that something well.

d. Potentiality. The term 'potentiality'[17] dates back to the early Latin translators of Aristotle, who used *potentia* and *actus* as translations of the Greek *dynamis* and *energeia*, respectively, terms which had already a multi-facetted use in the original Aristotelian texts,[18] and which have subsequently acquired an even broader variety of meanings. Here I will discuss only one conception of potentiality—as *nth-order disposition*—in order to contrast it with the other kinds of realizables presented here.[19]

A disposition D, we said, leads to a realization R in certain circumstances. Now, what if R is itself a disposition, say a disposition to become R*? Then D is a disposition to acquire another disposition, and one might say that D is the second-order disposition to become R*, i.e. the disposition to acquire a disposition to become R*. A patient may not have the disposition to be healed by a complicated operation because he is too weak to survive such a surgical intervention. But he may have the disposition to strengthen his constitution to the point where he may undergo the operation at a later time. Thus, although he does not have the disposition to be healed by an operation of this type, he does have the second-order disposition—the potentiality—to be healed in this way. Of course, dispositions of third or higher order are also conceivable. Having the potentiality for R, or so I want to stipulate, is to have an nth-order disposition for R, for some n.

e. Virtues. It has long been observed that virtues (and vices), too, are realizables. Virtues can be realized, but they need not to be realized in order to exist. A person can possess the virtue of being brave and yet not realize this virtue in brave deeds, e.g. because he never faces danger. Often, virtues are conflated with other kinds of realizables, such as dispositions or abilities. Virtues like bravery or justice are indeed connected with certain abilities. The just person, for example, has the ability to recognize just actions. But there are important differences between virtues and abilities. Not everyone who can tell just from unjust actions thereby himself possesses the virtue of justice. The just person is distinguished not only by the capacity to recognize what would be a just action in a given circumstance but also by a

standing desire to perform just actions once he has decided what they are. The just person has in this sense *a tendency to act justly* even while he retains *the ability to act unjustly*.

2.3   *How tendencies relate to the other kinds of realizables*

To be sure, words like "disposition" and "tendency" have a wide range of associated meanings in both ordinary and scientific discourse. Sometimes they can be used interchangeably, as in: "Radium-226 has the tendency or disposition to decay with a half-life of 1602 years". At other times the words clearly have different meanings; just compare "the tendency of a speech" with "the disposition of a speech" (where the words have meanings which are not even touched on in this paper). In the preceding sections, I used these terms to denote different sub-categories of realizables. How, now, do tendencies relate to those sub-catgories of realizables discussed above?

First, there is an obvious difference between sure-fire dispositions and tendencies along the dimension of reliability. To use Champlin's example: "If you knew you had to make a parachute jump from a plane and, perusing the parachute maker's operating instructions on the eve of your jump, your eyes lit on the words, 'Your parachute has a tendency to open when the rip-cord is pulled', wouldn't you feel at least a faint whiff of apprehension?"[20] What we aim for is a parachute that *invariably* opens when the rip-cord is pulled, i.e. a parachute that has a sure-fire disposition to this effect (even if we know that some real-world parachutes lack such a property). Thus, in contradistinction to sure-fire dispositions, tendencies are realizables that do not invariably realize themselves in appropriate circumstances.

A natural way to account for the lack of invariant realization is to identify tendencies with probabilistic dispositions. And some tendencies can indeed be treated in this way, and thus as distinct from sure-fire dispositions. The tendency of a collection of Radium-226 atoms to reduce to half their number within 1602 years could be regarded as such a probabilistic disposition, and this is the reason why in the mentioned context "disposition" and "tendency" can indeed be used interchangeably. But not all tendencies can adequately be described in these terms. The tendencies of classical dynamics, as we saw, are not always realized, even when they are 'active'; this, however, has nothing to do with probability or chance, but rather with the presence of competing tendencies.

The difference between tendencies and sure-fire dispositions is also made clear through the difference in our reaction to the non-realization in appropriate circumstances. We cannot at once uphold the thesis that some x is both in circumstances C and has a sure-fire disposition to R in circumstances C, but does not display R. In such a case we may either reject one of these beliefs about x, C or R, or revise our belief about what is to count as the actual set of relevant realization-conditions C. When faced with an analogous situation involving a tendency ascription (like "x has a tendency to R in circumstances C") there is no need for a belief revision of this kind.

Nor are tendencies sure-fire dispositions of a higher order, for nth-order sure-fire dispositions are realized with the same degree of reliability as one-step sure-fire dispositions, even if their realization stretched out among several stages. But, of course, there may be *tendencies* of higher order, i.e. tendencies to acquire tendencies. There may also be mixed higher-order forms, for example a sure-fire disposition to acquire a tendency, or a tendency to acquire a sure-fire disposition.

Tendencies differ from abilities, too. For a tendency, in order to be realized, normally requires nothing like a decision or act of free will. On the contrary, some philosophers think that there is a tension between describing people as following tendencies and describing them as free rational agents.[21] In fact, our decisions may block the realization of, say, certain bad tendencies we have. It might be the case, however, that people have tendencies to decide in certain ways. The virtuous person, for example, has the tendency to decide in favour of virtuous actions. Thus, virtues are a certain kind of tendencies: they are, as Aristotle pointed out, tendencies governing decisions and involving tendencies for emotions.[22]

All this shows that tendencies form a sub-category of realizables in their own right, next to other sub-categories like sure-fire dispositions. Here, we argued only for the distinctness of these sub-categories. We did not argue for the thesis that corresponding instances exist in the real world, though we did consider various candidate examples. It may, however, be an ontological possibility that the world should contain, for example, no sure-fire dispositions at all, but only tendencies, just as it is an ontological possibility that the world were to contain no virtues at all.

After this discussion, we are able to suggest a place for tendencies within a taxonomy of properties: Tendencies are realizable qualities with realizations that do not depend on decisions. We can illustrate this with the following taxonomic tree:

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                         ┌──────────────────┐
                         │     property     │
                         └──────────────────┘
              ┌────────────────────┴────────────────────┐
  ┌────────────────────────────┐        ┌────────────────────────┐
  │ not further realizable     │        │  realizable property   │
  │        property            │        └────────────────────────┘
  └────────────────────────────┘          ┌──────────┴──────────────┐
                          ┌────────────────────────────┐   ┌──────────────────────┐
                          │ realized by decisions:     │   │  otherwise realized  │
                          │         ability            │   └──────────────────────┘
                          └────────────────────────────┘      ┌─────────┴──────────┐
                                 ┌────────────────────────┐  ┌────────────────────────┐
                                 │ invariable realization:│  │  variable realization: │
                                 │   sure-fire disposition│  │       tendency         │
                                 └────────────────────────┘  └────────────────────────┘
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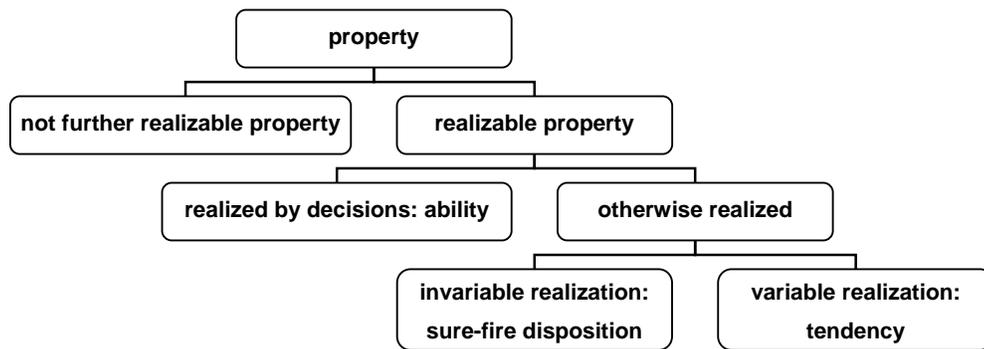
3   Tendency Ascriptions

3.1   Tendency Types and Tendency Tokens

Like virtually all entities, tendencies come in types on the one hand and tokens or instances on the other hand. Thus some tendency ascriptions are ascriptions of tendency tokens, while others are ascriptions of tendency types. Tendency tokens are ascribed to individual substances, e.g. to persons, as in: "Patient #0002 has a tendency to vomit", "Patient #0829 tends to get sunburn quickly" or "Patient #1203 suffers from ecdysiasm".[23] "The red haired have the tendency to get sunburn quickly", on the other hand, is an ascription of a tendency type to another type, in this case the type *being-red-haired*. Other examples are:[24]

- "The central regions of the protein show tendencies to form beta-bends."
- "Thought-action fusion is associated with tendencies towards obsessive-compulsive disorder."

- "Supplementation of FOS [= fructo-oligosaccharide] showed tendencies to increase total faecal nitrogen excretion".
- "Male self-cutters showed 'multi-impulsive bulimic' tendencies".
- "Male delinquent adolescent were found to have greater tendencies towards antisocial personality, sociability, being sexually abused, and alcohol and drug use."

As tendencies are causal properties, it is not surprising that such tendency ascriptions go along with causal assumptions. If a correlation between two kinds of entities is discovered, the first entity can be either the cause or the effect of the other entity, or both can be effects of a common cause. Being a delinquent adolescent is an *effect* of being sexually abused, while supplementation of FOS is the *cause* of an increase of faecal nitrogen excretion. Still other correlated kinds of entities are effects of a common cause—and maybe being a male self-cutter and showing multi-impulsive bulimic tendencies is an example of this type.

3.2   The Standard Square of Tendency Ascription

The examples given in the preceding section reflect the statistical methods used in modern medical research. The results brought about by statistical methods are correlations. Statistical correlations hold between types or universals. The correlations we are interested in here are, of course, those that involve types of tendencies. That is, we are interested in correlations between one universal U and another tendency universal T:

(S1)   U correlated-with T

On the other hand, in therapy medical practitioners deal always with individual patients. They never treat universals (at least not directly). Thus tendencies that are relevant in diagnosis and therapy come as tokens. Here totally different statement forms are relevant. They ascribe to an individual person x a tendency token t:

(S2)   x has t

The entities represented in statements like (S1) and (S2) are of course not unrelated to each other. Individuals like x in (S2) instantiate universals like U in (S1), and tendency tokens like t in (S2) instantiate tendency types like T in (S1):[25]

(S3)   x instance-of U

(S4)   t instance-of T

Putting (S1) to (S4) together, we get a square-shaped scheme. I will call it the "standard square of tendency ascription" or, simply, the "standard square", because it represents the typical case in which statements of all these four kinds are involved:

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U ——— correlated-with ——→ T

↑                          ↑

instance-of              instance-of

|                          |

x ——————————— has ———————→ t
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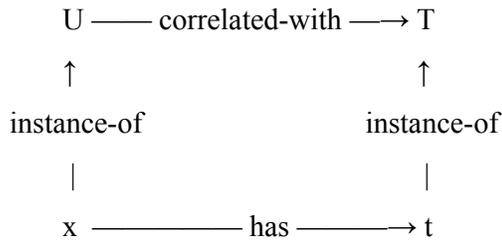
The relation between an individual like x or t and a universal like U or T need not be one-to-one. Individuals instantiate a multitude of universals, and a tendency instance t may instantiate various types of tendencies.[26]

The correlation we deal with in biomedical sciences are normally statistical results of empirical studies, many of them in laboratories. One and the same statistical result of a biomedical experiment can, of course, fit to totally different scenarios on the ontological level. Suppose that we observe 100 instances of a given universal U in situation S, but that in only fifty cases does R happen, i.e. in only 50 % of all cases is the realizable itself realized. There are several ontological scenarios that would explain this result. Here are two of them:

(A) Every instance of U has a tendency t to R in S where t has a probability of realization 0.5.

(B) Every second instance of U has a sure-fire disposition to R in S; the other instances of U do not have any disposition or tendency to R in S.

Both of these scenarios would explain the given observations. To distinguish between them we need to refer to tendency tokens (or disposition tokens) of individuals. It should be clear that it is vital for biomedical science to be able to draw this distinction. In case (A) the U make up a uniform population, where in case (B) they form two sub-populations with quite distinct features. This is one good reason to reserve a place for tendency tokens in our ontology.

Which treatment a medical practitioner will suggest may crucially depend on the scenario he takes to be the actual one. Which scenario we choose for our account of the observation will, in turn, depend on other observations and causal assumptions. If for example we knew that nearly always the same instances of U display R and nearly always the same instances of U do not display R, this would *prima facie* count as a reason to embrace (B). Thus if it is always the same patients who complain about migraine attacks after drinking red wine, then this would be evidence for ascribing a corresponding tendency to these patients individually. If, on the other hand, we know that the same instances of U sometimes do display R and sometimes do not display R, this would *prima facie* count as a reason to embrace (A) and thus to inquire into further background conditions pertaining to the U's, for example pertaining to the stability of the causal properties in question: how they can be stable over time, how (if at all) they can be acquired, and how they (if at all) can be lost. A genetic predisposition, for example, is quite stable during the lifetime of an individual, but may vary significantly across the members of a whole population. Exposure to different environmental influences, however, can even vary considerably during the lifetime of a single individual, not to mention the differences for different instances of the same universal in different geographical locations or social circumstances.

4 Two Deviant Cases

The reason why I called the square "standard" is that it represents the standard case of tendency ascription, i.e. the case in which all four components of the square are really present. But there are also non-standard cases. Rom Harré distinguishes between two such cases: tendencies "ascribed to a being just in so far as that being is a member of a class of such beings and so can be expected to share a common nature with its fellows" and "tendencies ascribed because of some unique and idiosyncratic configuration of its components".[27] I will discuss Harré's two cases in order.

4.1 Mere Correlations

The upper side of the square, or so I said, represents a statistical finding. Thus there may be plenty of instances of U that do not have any associated instance of the universal T. If x is such an instance, only the following torso of the standard square remains:

```
U —— correlated-with ——→ T

↑

instance-of

|

x
```
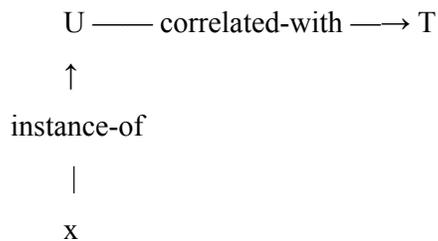
This is the first of two ways in which the ascription of a tendency may fall short of the standard case. It is important to bear this possibility in mind.

4.2 Contingent Individual Tendency

The other deviant case that Harré is hinting at is not so obvious, and I will argue that there are no examples for it. This second case corresponds to the following deviant square:

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                    T

                    ↑

               instance-of

                    |

x ———————— has ———→ t
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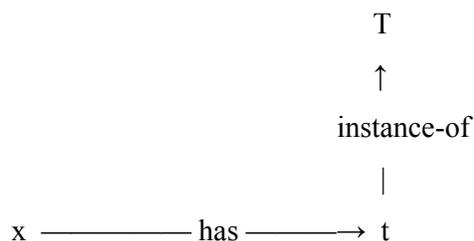
Is it a metaphysical possibility that a tendency token t could be *sui generis*? Is it conceivable that we have a case where there is a t instantiating some tendency universal T, but no U instantiated by x that is correlated with T? Having a tendency may come about through a combination of rare properties or events such that there is only one individual having this tendency. Someone might acquire a certain tendency, say, after abduction by aliens. However, even if only one person underwent this special treatment, one is inclined to assume that

anybody who eventually undergoes the same treatment would acquire a tendency token of the same type. Thus there actually is a universal U that is causally connected to the tendency in question, even if it happens that it has only one actual instantiation.

If the tendency in question happens to come into existence by some combination of several universals instantiated by the same individual, we should look for a conjunctive combination of these universals to fill the gap in the upper left corner of the square. There is, however, a dispute whether conjunctions of universals (like *Object_that_is_green_and_round*) name universals in their own right.[28]

But even if we reject conjunctive universals we may fill the gap, if we replace U by a plurality of universals U_1, U_2, ..., U_n, and add a new relation "conjunctively-correlated-with". Then we get something like the following:

$$U_1, \ldots, U_n \text{ --- conjunctively-correlated-with} \longrightarrow T$$
$$\uparrow \quad \uparrow \quad \uparrow \qquad\qquad\qquad\qquad \uparrow$$
$$\text{instance-of} \qquad\qquad\qquad\qquad \text{instance-of}$$
$$| \qquad\qquad\qquad\qquad\qquad |$$
$$x \longrightarrow \text{has} \longrightarrow t$$
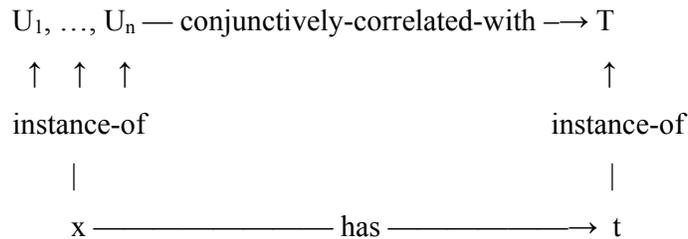
Thus even in this case there *is* a way to fill the gap, though it might be considered ontologically questionable to admit conjunctive properties or too *ad hoc* to substitute the relation "correlated with" with "conjunctively correlated with". Filling the gap in the alienabduction example, however, was neither *ad hoc* nor ontologically questionable. But, of course, such examples never bother the medical researcher, because correlations of universals that have only one instantiation can simply not be discovered by statistical means. Nor are such correlations useful to develop medical therapies that are meant to fit a wide range of patients.

4.3 Epistemic Variants

The previous discussion had a twofold conclusion. First, there are reasons to doubt the existence of contingent individual tendencies. One reason for this is our deeply rooted belief

in regularities in nature of the sort which are expressed in scientific laws. Second, in cases of the type discussed, the level of universals would be of no interest for the medical sciences because the universals in question would be instantiated by one individual only.

What will, however, be the case in the medical realm is that the square of tendency ascription will remain gappy because of a lack of knowledge about the tendencies in question. Such an epistemically gappy square can again come in two variants. First, we can start with the bottom line and get a gap in the upper left edge:

$$
\begin{array}{ccc}
? & & T \\
& & \uparrow \\
& & \text{instance-of} \\
& & | \\
x \xrightarrow{\quad\text{has}\quad} & & t
\end{array}
$$
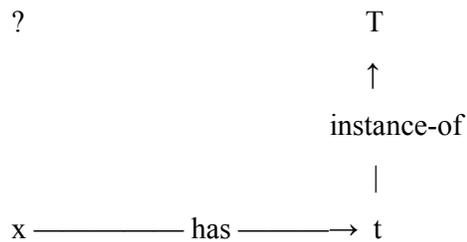
E.g., a patient may see the doctor and report that he has a tendency to vomit. It is the doctor's task to discover the universal instantiated by x that is correlated to the corresponding type of tendency in order to design a therapy for this patient. In many cases, it will more precisely be some part of x that instantiates a universal that is correlated with T's being instantiated by the whole organism of x. This mereological aspect deserves closer attention, but I will not discuss this issue here.

Second, a doctor may observe that a patient instantiates a certain universal U, and he may know that U is correlated with a certain tendency type T. From this, the doctor may assume with a certain probability that the patient himself possesses a token of this tendency. But as the correlation between U and T is only a statistical one, it admits of exceptions. Thus, the following situation is possible:

```
U ——— correlated-with ——→ T
 |
instance-of
 |
 x                          ?
```
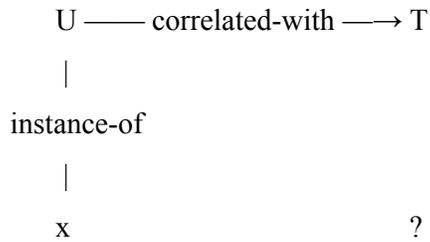
The doctor knows, first, that x instantiates U and, second, that U is correlated with tendency type T. But this is not enough to conclude that x possesses a tendency token t that instantiates T because, by assumption, the correlation between U and T is statistical only, and thus comes with exceptions. That is, not all instantiations of U possess tokens of T. The proper diagnosis in this situation is accordingly not:

   (DA)   x has a tendency t,

but rather something like:

   (DB)   Patient x instantiates a universal U that is correlated with a certain tendency type T. Therefore, there is a certain probability P that x possesses a token t, instantiating T.

This sounds a bit clumsy and so it might be helpful to illustrate the difference between (DA) and (DB) with the help of an example. It is the difference between *having a tendency* and *having the chance of having a tendency*: The probability of my developing the symptoms of Huntington Disease (HD) is very small when measured against all humans on earth. The probability for the offspring of a patient with this genetic disorder to develop HD later in life is much larger: The HD gene defect is transmitted with a probability of 0.5 to a member of the next generation. But only those who actually have the HD defect have a tendency to develop the symptoms, while those without the HD defect have no tendency to develop the symptoms whatsoever. Now, while the diagnostician does not have any information about the genes of a child (but only of the HD parent), his diagnosis must be of the (DB) form. But once the diagnostician learns that a child has the HD defect itself, the diagnosis must be of the (DA) form.

5 Conclusions

The ontology of tendencies, or so I have argued, is of vital importance for the representation of medical reality. For an appropriate representation of tendencies we need to be able to distinguish tendencies from other kinds of realizables. While tendencies share some features with other properties of the realizable-realization-structure such as dispositions, abilities, potentialities, virtues and so forth, they differ from these in a number of salient respects. For the diagnostician, ascriptions of both tendency tokens and tendency types are relevant, and they are connected to each other in a characteristic way that I modelled as the standard square of tendency ascription. In the standard case, ascriptions of tendency tokens go hand in hand with the correlation of a corresponding tendency type with another universal. As tendencies are causal properties, we will need causal background knowledge to represent tendencies appropriately, and any representation of tendencies will be a representation of possible causal relations For this, we need to know more about causal reasoning and we need new formal tools to relate realizables to their realizations. But these matters are already beyond the scope of the present paper.

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[2] Medline (ME66), available at: http://pubmed.gov (all figures as of December 5, 2005).

[3] Cf. Cleo Condoravdi, Dick Crouch, Martin van den Berg, "Preventing Existence", in: Chris Welty and Barry Smith (eds.), *Proceedings of the International Conference on Formal Ontology in Information Systems*, (New York: ACM Press, 2001), pp. 162-73.

[4] For the NCIT cf. http://nciterms.nci.nih.gov/ and Gilberto Fragoso et al., "Overview and utilization of the NCI Thesaurus", *Comparative and Functional Genomics* 5 (2004), 648-654. For the UMLS cf. http://umlsks.nlm.nih.gov and Peri L. Schuyler and William T. Hole,

"The UMLS Metathesaurus: representing different views of biomedical concepts", *Bulletin of the Medical Library Association* , 81 (1993), 217-222.

5 Metathesaurus search for "tendency" in UMLS Release 2005AB on 14.11.2005.

6 Cf. Werner Ceusters, Barry Smith, Louis Goldberg, "A Terminological Analysis and Ontological Analysis of the NCI Thesaurus", *Methods of Information in Medicine*, 44 (2005), 498-507.

7 Ingvar Johansson, "Tendency", in: Hans Burkhardt and Barry Smith (eds.), *Handbook of Metaphysics and Ontology* (Munich: Philosophia, 1991), vol. 2, p. 888.

8 Cf. Christoph Kann, "Tendenz", in: Joachim Ritter *et al.* (eds.), *Historisches Wörterbuch der Philosophie*, vol. 10 (Basel: Schwabe, 1998), pp. 998-1004.

9 Tendencies are discussed, e.g., in Roy Bhaskar, *A Realist Theory of Science* (2nd editon, Hassocks: Harvester Press, 1978); H. A. Nielsen, "Realism, Nominalism, and Wittgenstein", *Philosophical Investigations*, 3 (1980), 21-5; Quentin Gibson, "Tendencies", *Philosophy of Science*, 50 (1983), 296-308; T. S. Champlin, "Tendencies", *Proceedings of the Aristotelian Society*, 91 (1990/91), 119-33; Jacob Rosenthal, *Wahrscheinlichkeiten als Tendenzen. Eine Untersuchung objektiver Wahrscheinlichkeitsbegriffe* (Paderborn: Mentis, 2003); Ingvar Johansson, *Ontological Investigations. An Inquiry into the Categories of Nature, Man and Society* (2nd ed., Frankfurt: Ontos, 2004), ch. 11.

10 Daniel von Wachter, "How a Philosophical Theory of Causation May Help in Ontological Engineering", *Comparative and Functional Genomics*, 4 (2003), 111-4. Page numbers in the text refer to this article.

11 Cf. Johansson (cited in n. 9). Contrast von Wachter (cited in n.10), who considers forces not to be distinct from tendencies, but examples of them (p. 112).

12 Cf. the similar example in Nancy Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983), 51-2.

13 Witness, e.g., Raimo Tuomela (ed.), *Dispositions* (Dordrecht : Reidel 1978) ; Elisabeth Prior, *Dispositions* (Aberdeen: Aberdeen University Press, 1985); Stephen Mumford, *Dispositions* (Oxford: Oxford University Press, 1998).

[14] Stephen Mumford. *Dispositions* (cited in n. 13). For a defence of dispositions against this and other charges cf. also Ludger Jansen, "Dispositionen und ihre Realität", in: Christoph Halbig, Christian Suhm (eds.), *Was ist wirklich?* (Frankfurt: Ontos, 2004), pp. 117-37.

[15] Cf. Karl R. Popper, *A World of Propensities* (Bristol: Thoemmes, 1990); Jacob Rosenthal, *Wahrscheinlichkeiten als Tendenzen* (cited in n. 9).

[16] Cf. Ludger Jansen, "On Ascribing Dispositions", in: Max Kistler, Bruno Gnassounou (eds.), *Dispositions and Causal Powers* (Ashgate: Aldershot, 2007), pp. 161-179.

[17] Dietrich Schlüter, Akt/Potenz, in: Joachim Ritter *et al.* (eds.), *Historisches Wörterbuch der Philosophie*, vol. 1 (Basel: Schwabe, 1971), pp. 134-42.

[18] Ludger Jansen, *Tun und Können. Ein systematischer Kommentar zu Aristoteles' Theorie der Vermögen im neunten Buch der Metaphysik* (Frankfurt: Hänsel-Hohenhausen, 2002).

[19] Ludger Jansen, *Tun und Können* (cited in n. 18), pp. 197-8.

[20] T.S. Champlin, "Tendencies" (cited in n. 9), p. 121.

[21] Cf. Martin Hollis, *The Philosophy of Social Sciences: An Introduction* (revised and updated, Cambridge: Cambridge University Press, 1994), ch. 8.

[22] Cf. Cynthia Freeland, "Moral Virtues and Human Powers", *Review of Metaphysics*, 36 (1982), 3-23; Anselm W. Müller, *Was taugt die Tugend? Elemente einer Ethik des guten Lebens* (Stuttgart: Kohlhammer, 1998), pp. 138-9; Ludger Jansen, *Tun und Können* (cited in n. 18) pp. 88-92.

[23] Ecdysiasm is an abnormal tendency to take off one's clothes in order to produce sexual desire in others. UMLS 2005AB does not provide a definition for this term, but lists "Abnormal tendency to take off one's clothes" as a synonym.

[24] Cf. Medline (ME66), abstracts ME16098208, ME15792850, ME15787997, ME15896226, ME15886868. The last three items are verbal quotations.

[25] In the context of this paper, I do not discuss the relation between individual bearers of properties (i.e. Aristotelian substances) and property universals (like *Greenness* or *Roundness*), which is sometimes called "exemplification". Instead we will consider the

instantiation-relation between individual things and universals like *Green_object* or *Round_object*.

[26] A schema quite similar to the standard square of tendency ascription can be found in Jonathan Lowe, *The Four-Category-Ontology. A Metaphysical Foundation for Natural Science* (Oxford: Oxford University Press, 2006). Lowe, however, diverges from my account in several respects. First and foremost, he does not distinguish between different kinds of realizables. Second, he seems to deny the existence of tendency tokens and tendency universals in their own right. For him, the truth of the ascription of a tendency token to an individual is accounted for by the fact that this individual instantiates a universal that is correlated with (in Lowe's terms: is characterised by) the respective realization universal (rather than a tendency universal). Given such an account, we could not distinguish between the ascription of a realization R or a tendency to R to a universal. In biomedical science, however, both types of predicates are ascribed to universals. Thus we do need this possibility to represent biomedical knowledge. And we do need to distinguish between the two things that Lowe puts in one: Having a tendency token is not the same as instantiating a universal that is correlated with the respective realization universal.

[27] Rom Harré, *Varieties of Realism. A Rationale for the Natural Sciences*, (Oxford: Blackwell, 1994), p. 284.

[28] In favour of conjunctive universals argues David Armstrong, *A Theory of Universals. Universals and Scientific Realism*, vol. 2 (Cambridge: Cambridge University Press 1978), ch. 15. The opposite view is held by Reinhardt Grossmann, *The Categorical Structure of the World* (Bloomington: Indiana University Press, 1983), pp. 144-54.