

The Ontology of Tendencies and Medical Information Sciences

Ludger Jansen

Institute for Formal Ontology and Medical Information Science (IFOMIS),
Saarland University, Postbox 151150, 66041 Saarbrücken, Germany
ludger.jansen@ifomis.uni-saarland.de

Abstract. In order to develop the ontology of tendencies for use in the representation of medical knowledge, tendencies are compared with other kinds of entities possessing the realizable-realization-structure, specifically: dispositions, propensities, abilities and virtues. The peculiarities of tendencies are discussed and a standard schema of tendency ascription is developed in order to represent the relations between the ascriptions of tendency tokens to particulars and the ascriptions of tendency types to universals. Two non-standard cases and their epistemic variants are discussed.

1 Introduction

1.1 Why Tendencies are Important for Medical Information Sciences

It would sound a bit odd if a medical scientist was to describe his work as research on certain entities called “tendencies”. Nevertheless, a search in the Medline database yields 48884 hits for the word “tendency” plus 4720 hits for its plural. This is quite something, especially if one compares this with the figures for related terms (to be discussed in § 2): There are only 20991 hits for “disposition” (+ 916 for the plural) and 9639 hits for “propensity” (+ 728 for the plural).¹ Tendencies play important roles as medical findings. Such findings are, for example, a psychopathic tendency, a suicidal tendency or – to give examples of somatic sufferings – the tendency to bleed or a thrombophilic tendency. Also, many medications are designed to prevent the realization of tendencies. A patient with suicidal tendency will be treated in such a way that events of a certain kind, i.e. events being a suicide of this patient, will not occur (cf. [6]).

In the light of these facts, it is quite astonishing how little can be found about tendencies in medical terminologies such as the *National Cancer Institute Thesaurus* (NCIT) or the *Unified Medical Language System* (UMLS). The UMLS has no entry for “tendency” on its own, though it lists 23 hits for “tendency” either in the lemmas

¹ Medline (ME66), available at: <http://www.medline.de> (all figures as of December 5, 2005).

or in their definitions.² The NCIT lacks an entry *Tendency* as well. It has, however, an entry *Disposition*, which is defined in terms of a tendency:

NCI|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: “Nature” is distinct from “quality”, and both are distinct from “orderly arrangement”. “Disposition” in the NCIT seems not to signify a unique concept, contrary to the official intention of the NCIT [4], but rather a somewhat confused bundle of concepts. 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 those tendencies “to act in a certain manner under given circumstances resulting from natural constitution” should be listed as sub-items here. Given the widespread occurrence of words like “tendency” and “disposition” in the research literature (as proven through the Medline results), it would be very much desirable that the terminologies reflect this importance by adequately representing these properties.

1.2 Previous Work

Standard accounts define a tendency as “an entity which can be counteracted by other tendencies” or as “a potentiality which may be exercised without being realized” [14]. The first of these definitions being circular and the second introducing three new undefined terms, these definitions are not rigorous enough to be implemented within information systems. Thus we have to investigate the topic beyond these standard answers. While discussion of tendencies can be traced back – at least – to Aristotle and what he says on *dynamis*, *physis*, and *hexis* [16], there is comparatively little discussion of tendencies in recent philosophical literature. Tendencies are being discussed, e.g., in [2], [5], [7], [15, ch. 11], [20], [23]. Furthermore, Daniel von Wachter has pointed out that the ontology of tendencies may help in ontological engineering [27]. His account of tendencies, however, gives rise to the following three problems.

Who is the Bearer of Tendencies? Firstly, in von Wachter’s eyes, states of affairs are the bearers of tendencies. States of affairs are, in a nut shell, all those complex entities that can be described in that-clauses. Examples are the state of affairs that Rosie has red hair or that patient #12 is slightly green in the face. There is a point to ascribing tendencies to complex entities like state of affairs, because in this way one may get a hand on circumstances necessary for a certain outcome. Circumstances play an important role that should not be neglected. But in medicine, tendencies are often ascribed not to states of affairs, but to patients, i.e. to substances, to concrete things

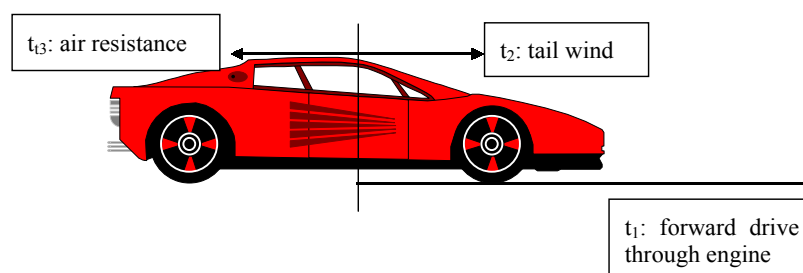
² Metathesaurus search for “tendency” in UMLS Release 2005AB on 14.11.2005.

existing in time and space. It is a patient that has a suicidal tendency or a tendency to bleed, not a state of affairs. And it is patients that are to be healed, not state of affairs. I will, therefore, focus on tendencies as ascribed to substances.

Causality and Tendency Bases. Secondly, presenting a tendency-theory of causality, von Wachter wants to answer “the ontological question about causation: [...] what it is in reality that makes causal statements true” [27, p. 113]. At the core of von Wachter’s tendency-theory is the following biconditional: “A caused B if and only if A was the basis of a tendency towards B and the tendency was realized” [27, p. 113]. Here, “A” and “B” are variables for states of affairs. The basis of the tendency is the “state of affairs at t_1 that is relevant for the obtaining of the tendency” [27, pp. 112-113]. Thus the causality-claim gives us a criterion for when to say that something of the form “That this-and-this was the case causes that that-and-that is the case”. But how do the basis and the tendency relate? Are they identical? Does the basis A constitute the tendency? Is the basis a cause of the tendency? And why is the tendency important at all, if it is the basis A which causes the event B? The following account tries to avoid these problems by admitting tendencies as properties of things in their own right.

Are all Monopolised Tendencies realized? Thirdly, von Wachter claims: “A tendency will be realized if and only if there is no counteracting tendency” [27, p. 112]. But this principle is highly problematic. I will argue that it is neither necessary nor sufficient for the realization of a tendency that there are no counteracting tendencies.

Firstly, the absence of counteracting tendencies is not necessary. This can, e.g., be seen in Newtonian physics. There are good reasons to consider physical forces as something relational: a force relates, e.g., a certain field to a certain body it acts upon. A physical tendency, however, is a property of a body – a property that, e.g., has been brought about by a force acting on this body [15]. Now imagine a Ferrari with three tendencies – like the one depicted here:



This Ferrari has a tendency t_1 to drive forward through its running engine, a considerable smaller tendency t_2 to drive forward through the tail wind, and a tendency t_3 not to drive forward through the air resistance. Now imagining that the forces that bring about t_2 and t_3 are of equal size. Then t_1 will 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 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. Therefore, contrary to von Wachter's claim, the fact that a tendency is not counteracted is neither necessary nor sufficient for its realization. Thus a general ontology of tendencies should not ascribe to this principle.

Tendencies in Sciences. Having used examples from classical physics and quantum mechanics, I should add two remarks on tendencies in different sciences. First, within classical dynamics it is very easy to add up all tendencies. All tendencies are brought about by forces that are measured by the same physical unit, Newton, and can be represented as vectors that can easily be added to other vectors. Because of the mathematical properties of vectors and the sameness of the unit of measurement used, all the tendencies involved easily add up to a definite result. Such a straightforward addition of tendencies is not possible in all cases. If a petunia has the tendency to flourish when placed in a sunny place and the tendency to starve when given too much water, then which tendency does it have when placed in a sunny place with an overload of water? (Cf. [3].) Or consider human agents, which are acted upon by very different "forces" or influences, such as social, psychological and genetic influences. Influences of these kinds normally do not come with a number and a unit of measurement affixed to them. This makes it much more difficult to combine several singular tendencies to a single resulting tendency.

Second, classical dynamics is a deterministic theory. In such theories, the resulting tendency gives directly rise to what is going to happen, the event to follow. We are able to leave the realm of tendencies and enter the realm of (often observable) happenings. In this, they differ from indeterministic theories like quantum mechanics and even more from theories, e.g. from the humanities, that take into account free will bringing about spontaneous actions. For in indeterministic theories, the resultant tendency in no way amounts to a guarantee of one and only one consequent happening: we remain within the realm of probabilistic tendencies and have to wait to find out what will actually happen. Many medical tendencies are of this latter kind.

2 Tendencies and their Realizations

2.1 Realizables: A General Structure

Tendencies are a special kind of properties. They are special in that they "point" to something that they enable or cause or make probable: their realization. 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 qualitative property, bleeding is a process or an 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 the tendency to bleed at a time when he is not bleeding. I will call all properties that share this structure “realizables”. Tendencies are one kind of them. They share the following features with other realizables: (1) They are qualities. (2) They are related to some other entity which they cause, enable or make probable. This entity is called their “realization”. And: (3) They can exist independently of their realization. There is a whole variety of realizables other than tendencies, and some of them have a long history as technical terms in philosophical debates. In order to contrast them with tendencies, I will discuss the following other kinds of realizables: disposition, propensity, ability, potentiality, and virtue.

2.2 Different Kinds of Realizables

Dispositions. In recent decades, a lot of work in philosophy of science and ontology has been dedicated to dispositions; witness [12], [13], [15], [21], [26]. The major part of this work has centred around ‘sure-fire’ dispositions, i.e. 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.”

Typical disposition ascriptions thus are “Sugar has the disposition to dissolve when put in water” or “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” D but only its realization R. While this is true, it does not make dispositions “occult”. On the contrary, a disposition ascription of the above form entails a test procedure for disposition D: Put x in circumstances C and watch whether x becomes R (cf. [18, pp. 73-78]; cf. also [12] for a defence of dispositions against this and other charges).

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 (cf. [22], [23]). Therefore they are also called ‘probabilistic dispositions’ (e.g. in [13]).

Abilities. Another kind of realizables are 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 depends on its bearers decision to do so. Realizations of abilities are actions. Thus, with abilities we enter the sphere of free will. Third: When we talk about abilities, we often mean not only the ability to do something, however clumsily, but the ability to do something well.

Potentiality. Potentiality is a term old of age and rich in ambiguity [24]. It dates back to the early Latin translators of Aristotle, who used the terms *potentia* and *actus* to translate his terms *dynamis* and *energeia*. Being already a multi-faceted term in Aristotle [11], it acquired an even broader variety of meanings in the course of the history of philosophy. Here, I will only discuss one possible meaning of this term in order to contrast it with the other kinds of realizables presented here, namely the conception of potentiality as a n-order disposition [11, pp. 197-198]).

A disposition D, I have suggested, 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*. For 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 the very same patient may have the disposition to strengthen his constitution to the effect that he may undergo the operation at a later point of time. Thus, although he does not have the disposition to be healed by this operation, he has the second order disposition or potentiality to be healed in this way. Of course, not only second order dispositions are conceivable, but also dispositions of third or higher order. Now having the potentiality for R, or so I want to stipulate, is to have an n-order disposition for R, for some n. The example shows that potentialities or higher order dispositions are important for medical practice, too.

Virtues. Since long it has observed that virtues (and vices) are also realizables: virtues can be realized but they need not to be realized in order to exist. A person can possess the virtue of being just and not realize it in just deeds, e.g. while sound asleep. Often, virtues are conflated with other kinds of realizables like dispositions or abilities. Virtues like justice are indeed connected with certain abilities. The just person, e.g., has the ability to point out just actions. But there are important differences between virtues and abilities. Not everyone who can tell just from unjust actions possesses the virtue of justice. The just person can not only tell just actions. He is distinguished by a standing desire to perform just actions once he has decided what they are: The just person has a tendency to act justly, though he retains the ability to act unjust.

There is yet another interesting difference between abilities and virtues: A skilled craftsman may decide to deliver a bad work, e.g. for reasons of vengeance, and still remain a highly skilled craftsman. Deliverance of a bad work does not entail the loss of the skill. If, however, “someone cheats somebody or knowingly breaks a promise, this proves that he lacks the virtue of justice” [19, p. 82; my translation].

2.3 How Tendencies Relate to the Other Kinds of Realizables

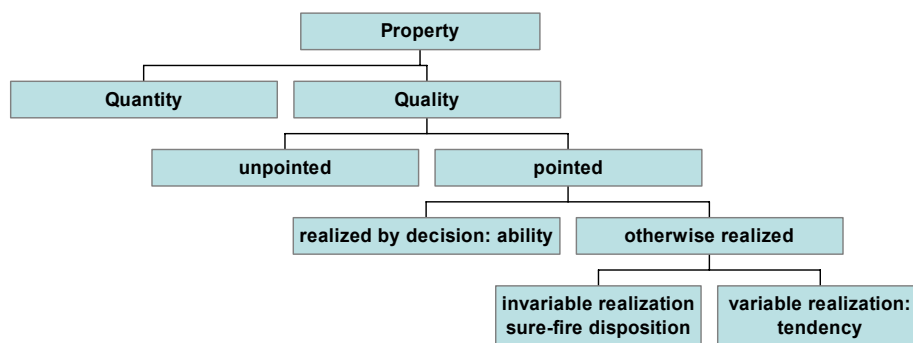
Now, how do tendencies relate to the kinds of realizables discussed above? First, there is an obvious difference between sure-fire dispositions and tendencies in terms of reliability. While sure-fire dispositions invariably realize themselves in certain circumstances, tendencies do not do this. To use T. S. 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?" [5, p. 121] Thus, a lot of tendencies seem to be rather probabilistic dispositions than sure-fire dispositions. But not all tendencies can adequately be described as probabilistic dispositions. That the tendencies of classical dynamics (which I have discussed in § 1.2) are not always realized, has nothing to do with probability or chance.

Nor are tendencies n-order sure-fire dispositions, for there the same degree of reliability applies, if only at several stages. But, of course, there may be tendencies of higher order, i.e. tendencies to acquire tendencies. There may also be mixed forms of higher order, e.g. a disposition to acquire a tendency or the tendency to acquire a disposition.

Tendencies differ from abilities, too. For a tendency, in order to be realized, normally no decision, no act of free will is necessary. On the contrary, some philosophers think there is a tension between describing people as following tendencies and describing them as free rational agents [10, ch. 8]. In fact, the decision we make may block the realization of, say, 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 the virtuous action. Thus, virtues are a certain kind of tendencies: They are tendencies governing decisions and involving tendencies for emotions, as Aristotle pointed out (cf. [19, pp. 138-139], [11, pp. 88-92]).

After this discussion, we are able to point out the following place for tendencies within a taxonomy of properties: Tendencies are pointed qualitative properties, i.e. realizable, with variable realizations that do not depend on decisions. We can illustrate this with the following taxonomic tree:



3 Tendency Ascriptions

3.1 Tendency Types and Tendency Tokens

Like virtually all entities, tendencies come in types and tokens. 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. “Patient #12 has a tendency to vomit”, “Rosie tends to get sunburn quickly” or “Mr Smith suffers from ecdysiasm”³ are such ascriptions of tendency tokens to individuals. “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:⁴

- “The central regions of the proteine show tendencies to form beta-bends.”
- “Thought-action fusion is associated with tendencies towards obsessive-compulsive disorder.”
- “Supplementation of [the chemical] 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.”

These examples give rise to a warning: Tendencies are thought of as causal properties. If a correlation between two kinds of entities is discovered, the first entity can be the cause or the effect of the other entity, or both can be effects of a common cause. Because of its temporal posteriority, being a delinquent adolescent is an effect of being sexually abused, while supplementation of FOS is the cause of the 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 – which is the same – 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 a universal U and another universal UT that is a tendency type:

³ Ecdysiasm is an abnormal tendency to take off one's clothes in order to produce sexual desire in others. UMLS 2005AB does not have a definition, but lists “Abnormal tendency to take off one's clothes” as a synonym.

⁴ Cf. Medline (ME66), abstracts ME16098208, ME15792850, ME15787997, ME15896226, ME15886868. The last three items are verbal quotations.

(S1) U_correlated_with_T

On the other hand, in therapy medical practitioners always deal with individual patients. They never treat universals. Thus tendencies that are relevant in diagnosis and therapy come as tokens. Here totally different types of statements are relevant. They ascribe to an individual person x a tendency token t:

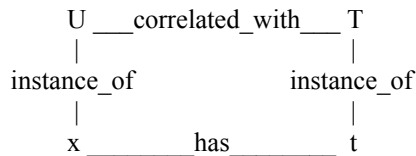
(S2) x_has_t

The entities 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):

(S3) x_instance_of_U

(S4) t_instance_of_T

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



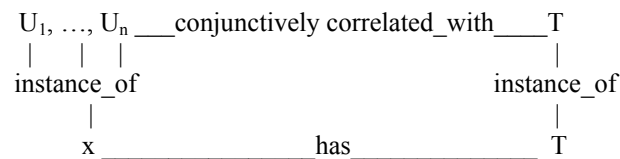
The relation between an individual like x or t and a universal like U or T is not a unique one. Individuals instantiate a multitude of universals, and t may instantiate various types of tendencies.

4 Two Deviant Cases

The reason why I called the standard 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. This does, of course, not entail that there are no non-standard cases. Two kinds of non-standard cases are, for example, mentioned by Rom Harré: “Sometimes a tendency is to be ascribed to a particular being because of some unique and idiosyncratic configuration of its components; sometimes a tendency is ascribed to a being just in so far as that being is a member of class of such beings and so can be expected to share a common nature with its fellows.” [9, p. 284] I will discuss these two cases in reverse order: First, I will discuss the case of mere statistical correlations, second the problem whether there may be “idiosyncratic” or contingent individual tendencies.

a certain tendency, say, after an abduction by aliens or through a calling by a divine entity. However, even if only one person underwent this special treatment after she has been abducted by aliens, one is inclined to assume that anybody who eventually undergoes this special treatment will get 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. Similar things apply to the other example. Even if God transfers a special tendency to one chosen individual only, it would be odd to assume that an almighty being should not be able to transfer such a tendency to any of his chosen ones. Thus, in this situation “chosen by God to possess a tendency of type T” names a universal U that is causally connected to T, even if it should turn out that there is only one individual that instantiates this universal.

If the tendency in question happens to come into existence in a more secular way by combination of different properties, we should look out for a conjunctive combination of types of these properties to fill the gap in the upper left corner. There is, however, a dispute whether conjunctions of properties (like “green and round”) name a universal in its own right (cf. [8, pp. 144-154], [25, §§ 41-45] on the contra side and [1, ch. 15] on the pro side). But even if we reject conjunctive property universals we may fill the gap, if we replace U by a set of universals $U_1, U_2, U_3 \dots$. Then we get something like the following:



Thus even in this case there is a way to fill this gap, though it might be considered to be 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 alien-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. Second, in the example discussed, the level of universals is of no interest for the medical profession, because these universals were instantiated by one individual only. What will, however, regularly be the case in the medical profession is that the square of tendency ascription remains 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:

5 Conclusions

The ontology of tendencies, or so I have argued, is of vital importance for the representation of medical knowledge. While tendencies share some features with other properties of the realizable-realization-structure, like dispositions, abilities, potentialities, virtues and vices, they differ from these in a number of salient respects. For the medical practitioner, both ascriptions of tendency tokens and of tendency types are relevant, which 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. I discussed the possibility of two deviant cases, where either there is no correlated universal or no tendency token and their epistemic counterparts, where it is not known what the correlated universal is or whether the patient is a bearer of the tendency token. Any representation of medical knowledge should allow for all these possibilities and be able to distinguish between them.

Acknowledgements

The present paper was written under the auspices of the project Forms of Life sponsored by the Volkswagen Foundation. I am indebted to Ingvar Johansson and Andrew D. Spear for discussions and comments on an earlier versions of this paper.

References

- [1] David Armstrong. *A Theory of Universals. Universals and Scientific Realism*, vol. 2, Cambridge University Press: Cambridge 1978.
- [2] Roy Bhaskar. *A Realist Theory of Science*, 2nd edition, Harvester Press: Hassocks 1978.
- [3] Nancy Cartwright. *How the Laws of Physics Lie*, Oxford University Press, Oxford 1983.
- [4] Werner Ceusters, Barry Smith, Louis Goldberg. A Terminological Analysis and Ontological Analysis of the NCI Thesaurus, *Methods of Information in Medicine* 44: 498-507, 2005.
- [5] T.S. Champlin. Tendencies, *Proceedings of the Aristotelian Society* 91, 119-133, 1990/91.
- [6] Cleo Condoravdi, Dick Crouch, Martin van den Berg. Preventing Existence. In: C. Welty, B. Smith, (eds.), *Proceedings of the International Conference on Formal Ontology in Information Systems (FOIS-2001)*, ACM Press, New York 2001, 162-173.
- [7] Quentin Gibson. Tendencies, *Philosophy of Science* 50: 296-308, 1983.
- [8] Reinhardt Grossmann. *The Categorical Structure of the World*, Indiana University Press, Bloomington 1983.
- [9] Rom Harré. *Varieties of Realism. A Rationale for the Natural Sciences*, Blackwell, Oxford 1994.
- [10] Martin Hollis. *The Philosophy of Social Sciences: An Introduction*, revised and updated, Cambridge University Press 1994.
- [11] Ludger Jansen. *Tun und Können. Ein systematischer Kommentar zu Aristoteles' Theorie der Vermögen im neunten Buch der Metaphysik*, Hänsel-Hohenhausen, Frankfurt 2002.

- [12] Ludger Jansen. Dispositionen und ihre Realität. In: Christoph Halbig, Christian Suhm (eds.), *Was ist wirklich?*, Ontos, Frankfurt 2004, 117-137.
- [13] Ludger Jansen. On Ascribing Dispositions, In: Max Kistler, Bruno Gnessounou (eds.), *Dispositions and Causal Powers*, Aldershot: Ashgate 2006, in press.
- [14] Ingvar Johansson. Tendency. In: Hans Burkhardt, Barry Smith (eds.), *Handbook of Metaphysics and Ontology*, Philosophia, Munich 1991, vol. 2, 888.
- [15] Ingvar Johansson. *Ontological Investigations. An Inquiry into the Categories of Nature, Man and Society*, 2nd edition, Ontos: Frankfurt 2004.
- [16] Christoph Kann. Tendenz. In: Joachim Ritter et al. (eds.), *Historisches Wörterbuch der Philosophie*, vol. 10, Schwabe, Basel 1998, 998-1004.
- [17] Jonathan Lowe. *The Four-Category-Ontology. A Metaphysical Foundation for Natural Science*, Oxford University Press: Oxford 2006.
- [18] Stephen Mumford. *Dispositions*, Oxford University Press, Oxford 1998.
- [19] Anselm W. Müller. *Was taugt die Tugend? Elemente einer Ethik des guten Lebens*, Kohlhammer: Stuttgart-Berlin-Köln 1998, 82.
- [20] H. A. Nielsen. Realism, Nominalism, and Wittgenstein, *Philosophical Investigations* 3: 21-25, 1980.
- [21] Elisabeth Prior. *Dispositions*, Aberdeen University Press, Aberdeen 1985.
- [22] Karl R. Popper. *A World of Propensities*, Thoemmes, Bristol 1990.
- [23] Jacob Rosenthal. *Wahrscheinlichkeiten als Tendenzen. Eine Untersuchung objektiver Wahrscheinlichkeitsbegriffe*, Mentis, Paderborn 2003.
- [24] Dietrich Schlüter. Akt/Potenz. In: Joachim Ritter et al. (eds.), *Historisches Wörterbuch der Philosophie*, vol. 1, Schwabe, Basel 1971, 134-142.
- [25] Barry Smith. *The Ontology of Reference: Studies in Logic and Phenomenology*, Ph.D. Thesis, University of Manchester 1976; <http://ontology.buffalo.edu/smith/Dissertation/>.
- [26] Raimo Tuomela (ed.). *Dispositions*, Dordrecht 1978.
- [27] Daniel von Wachter. How a Philosophical Theory of Causation May Help in Ontological Engineering, *Comparative and Functional Genomics* 4: 111-114, 2003.