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On Ascribing Dispositions

1. They Do It

Teachers do it. Engineers do it. Scientists do it. Insurance agents do it. Both plain and sophisticated folks do it. What do they do? They ascribe dispositions.

- Teachers do it in class. They call some students "witty" and some "lazy". They call some "intelligent" and some – though only in private – "stupid".

- Engineers do it on the job. They build bridges which they call "stable". They invent textiles which they call "water-resistant". And for their work they use materials that are, for example, called "non-flammable" or "flexible".

- Scientists do it in the lab. They utter sentences like "Aspirin relieves headaches", "Sugar is water-soluble" or "Porcelain is an insulator". Or such sentences like "Mass-points attract each other", "Neutrinos have a half-life period of so-and-so long". And many of these sentences find their way into scientific articles, manuals and textbooks.

- Insurance companies do it for money. They classify smokers as being more liable to have health problems than non-smoking people. They expect women to cause higher expenses in hospital than men, who still cannot give birth to children. And they expect (at least in some countries) civil servants to cause fewer car accidents than the average driver.

In this paper I want to exploit the fact that ascriptions of dispositions are actions. So far, I listed some examples of disposition ascriptions, which give us an impression about *who* performs such actions and about the variety of different kinds of disposition ascriptions. In what follows I want to answers the questions *why*, *how* and *when* we ascribe dispositions in sections 2, 3, and 6, respectively. And, as ascribing always is ascribing something to something, I will ask in section 4: *What* do we ascribe when we ascribe dispositions? And in section 5: *To whom* do we ascribe dispositions?

2. Functions: Why Ascribe Dispositions?

In the examples given, the ascriptions of dispositions serve quite different functions. One of the main motivations for ascribing dispositions is the wish to explain. Teachers want to *explain* why some students learn quicker than others. Next comes the necessity to choose certain actions to *react* to a given situation. The reaction will depend on the dispositions ascribed. E.g., the pedagogical reaction to a student's failure in an exam depends, among other factors, on the intelligence ascribed to the student by the teacher: A teacher will treat a less intelligent student differently than an intelligent but under-achieving student.

In the case of engineers and scientists, these two functions of disposition ascriptions are roughly divided between the two professions. While scientists primarily want to explain what happens in the world and thus ascribe dispositions to the things involved, engineers take into account these dispositions and choose materials and constructions accordingly. Insurance companies are a similar case. They react to known or assumed dispositions, taking them into account in the statistical calculus used to calculate the cost of a policy. Presumably, they do this without any wish to explain anything.

3. Pragmatics: How to Ascribe Dispositions?

Obviously, disposition ascriptions like "Jennifer is intelligent" or "This bridge is stable" are predications. In such predications, certain predicates are ascribed to certain individuals. Other dispositions seem to be more tricky, like "Aspirin relieves headaches" or "Mass-points attract each other". Later, I will discuss these more sophisticated kinds of disposition ascriptions in detail (section 5). Here it will suffice to stick to plain predications to get my points across.

Let's suppose that I want to cross a river, and there is only a tiny little bridge. Someone tells me: "This bridge is stable." If I trust him, I will trust the bridge. I will suppose that the bridge will securely support me while walking over it, or the weight of my car while driving over it. Will I suppose that the bridge will support any weight? No, I won't. I will suppose that the bridge will crash down if the weight exceeds a certain limit. And if I know a bit of physics I may also know that the bridge might be destroyed by much smaller forces, if these are applied rhythmically, for example by a group of soldiers marching in step. Will I then think that my informant was wrong, that the bridge in reality is not stable at all? Again: No, I won't. I will understand the sentence "This bridge is stable" as being short for: "This bridge is so stable as to support any weight which will be put on it in the course of any action which I suppose you will undertake involving the bridge." Thus this disposition ascription is elliptical. Nevertheless we achieve communicational success, because in most cases we have shared assumptions about the action that walkers or car drivers do with bridges: they cross them.

Often it is said that such disposition ascriptions refer to something like "normal" conditions.[1] But this misses the point. Because often it is not the normal condition but an extreme condition which is in question. If I am an army lieutenant, commanding a company of infantry, I expect a different piece of information about the bridge than the normal walker or car driver. I have to know how many people and cars may be on the bridge simultaneously, and whether or not the infantry may march in step. Now, the sentence "The bridge is stable" may be short for "The bridge is so stable as to support a company of infantry when marching

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[1] Cf., e.g., Spohn 1997, who nevertheless gets interesting results from this assumption.

in step." And this is quite a different disposition than that asked for by normal car drivers.[2]

If such disposition ascriptions are elliptical, how is successful communication about dispositions possible? It is possible, because, like in many other kinds of discourse, additional information is provided by the context of the utterance or by tacit mutual assumptions of the speaker and the hearer. This is enough to give action-related information involving dispositions. But is it enough for scientific descriptions? This is not so clear, because there is no related action for science as such – only the desire to explain. I do not want to discuss this question further here. Instead, I will next discuss in which ways a disposition ascription can be elliptical. Even if the context should also turn out to be helpful in the case of explanation, science will be better off trying to fill these gaps. For the aim of science is to make things explicit. As it is not implicit but explicit knowledge science aims at, science should strive to find explicit formulations of its findings.

4. Syntax: What is Ascribed?

We ascribe dispositions by ascribing predicates. So much seems to be clear. Thus the surface grammar of a disposition ascription is plain and simple predication, consisting of a disposition predicate ("D") and a singular term ("x") as a subject:

$$D(x)$$

Now a disposition is always a disposition for some kind of action, its specific manifestation M. Thus, somehow this manifestation predicate must be hidden within the disposition predicate. My suggestion is to express the relation between a manifestation predicate and the related disposition predicate by means of a predicate modifier. A predicate modifier is an operator that takes a predicate and yields a new predicate.[3] Here I use the modifier "dyn", so-called in reminiscence of Aristotle's concept of *dynamis*.[4] Thus, hidden behind the surface is something like

$$(dyn\ M)(x)$$

Now, dispositions can differ, because they allow for different manifestations. Say, supporting a certain mass m_1, or supporting a larger mass m_2 etc. Furthermore dispositions can differ, because they allow for the same manifestation under different conditions, say in different temperatures. A bridge built from ice may have the disposition to support a car under a temperature of -20°C, but not the disposition to support a car under a temperature of 10°C. Thus we have to account for the possibility of such different conditions in disposition ascriptions. The best way to do this is to recognise that the manifestation predicate M can form a complex conjunctive predicate together with a condition predicate C, e.g. "... has a temperature of 10°C". Thus we now arrive at the following structure:

$$(dyn\ (M.C))(x)$$

The predicate conjunction "." is defined as follows: If *A* and *B* are predicates, *A.B* is also a

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[2] Similarly, Mumford 1998, 90 speaks about „the context relativity of relevant ideal condition". However, Mumford misses the ambiguity of manifestation terms, which is in question in the bridge example. See the discussion in the next section. In addition it is not clear how Mumford thinks that the context contributes to the meaning of disposition ascriptions.

[3] Cf. Clark 1970. For discussion and further references cf. Jansen 2002, ch. 1.

[4] Cf. Jansen 2002.

predicate. $(A.B)(x)$ is true, if and only if both $A(x)$ and $B(x)$ are true.[5] It might seem odd that – due to this conjunctive analysis – the manifestation predicate and the manifestation conditions are on equal footing. Some may want to object that in this case the manifestation predicate and the condition predicate have symmetrical roles and that they may even switch places. This is true, but it should not bring us any trouble. If a bridge has the disposition D_1 to support a car while having a temperature of 10°C, it also has – indeed as a logical consequence – the disposition D_2 to have a temperature of 10°C while supporting a car. Bridges without this disposition would just cease to exist when reaching a temperature of 10°C while supporting a car. There is nothing wrong with this. The reason, why the ascription of D_2 sounds odd but not the ascription of D_1 is that bridges are built to support cars; that they can stand certain temperatures is only of instrumental value for this end. However, everything that possesses D_1 also possesses D_2, and vice versa. This is, why the conjunctive analysis is appropriate for manifestation conditions.

Of course, the predicate C describing the manifestation conditions can itself be a highly complex predicate. The task of science is to learn as much as possible about the predicates M and C involved, and thus to accumulate as much explicit knowledge about the dispositions of the things we find in the world as possible. I discuss how knowledge about dispositions can be acquired in section 6.

Another objection may arise:[6] Disposition ascriptions, or so the objection starts, should allow us to predict future outcomes. But if we ascribe dispositions, as stated, always for very special manifestations in very special circumstances, dispositions are of no use for predictions, because we do not know whether these very special circumstances will obtain in the first place. We may, for example, ascribe to a bridge the disposition to support our weight at a temperature of 20°C and an atmospheric pressure of 1013 hPa. But then it is quite unlikely that the weather produces these very conditions, and thus we cannot predict any outcome of our walking across the bridge. So much for the objection, now my answer. While I agree to the objection's premises, I do not subscribe to its conclusion. It is true, I think, that we cannot predict much if we only know a thing's disposition to react in a certain way in one set of circumstances. But what we usually ascribe to things is a whole family of disposition predicates, describing the reaction in a whole range of circumstances. And in many cases it will be fairly certain that circumstances from this range will obtain in a future situation. For example, we may ascribe to the bridge the disposition to support our weight at any temperature from, say −60°C to 60°C, thus covering virtually any temperature conceivable in earthly climates. Whatever the temperature will be like in a future situation, the bridge will support our weight because of its dispositional properties. Thus, even if disposition ascriptions are elliptical in the way described in this section, they still allow for prediction if they cover an appropriate range of circumstances.

Someone who prefers sparse ontologies may want to object here that this suggestion multiplies the number of dispositions: the disposition to support at 1°C, 2°C, 3°C etc., and of course also the temperatures in between, say, at 1.27°C or 37.93°C. But what is being multiplied here is the number of disposition predicates that can be ascribed to the bridge, the number of disposition ascriptions. Thus it is a multiplication at the level of description. Whether this procedure brings with it a multiplication at the level of being, at the ontological

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[5] Cf. Jansen 2002, 183.

[6] This objection has been raised by Nancy Cartwright in discussion.

level, depends on one's theory of token identity of dispositions. That all these disposition ascriptions are true of a thing might be accounted for by one and the same property token. Thus there may be different disposition tokens that make this wide range of disposition ascriptions true, but this is not necessarily so: Maybe there is only one property token that makes all these disposition ascriptions true.

5. Ontology: To Whom are Dispositions Ascribed?

5.1 Four Candidates

The question to which I want to turn now is: To whom are dispositions ascribed? As an initial approach to answering this question we can look for the grammatical subjects of disposition ascriptions. Browsing through the examples I mentioned at the beginning, we find things like:

- John and Jennifer, two students: John is witty and Jennifer is intelligent.

- The old Forth Bridge and the new Forth Bridge, two constructions by civil engineers: The new Forth Bridge is stable, the old one wasn't.

- Gum and Gore-Tex, two materials: Gum is flexible, Gore-Tex is water-resistant.

- Mass-points and neutrinos, theoretical entities of quite different standing.

- Smokers and civil servants: Smokers are more liable to have health problems, civil servants less liable to cause accidents than the average driver.

In reflecting on this list, different categories of entities come to mind: Living versus non-living entities. Theoretical versus non-theoretical entities. Different things versus different kinds of stuff. And, more important, individuals versus kinds. Consider the following sentences:

(S)   Zucky (= my favourite chunk of sugar) is water-soluble.

(K)   Sugar is water-soluble.

Of course, in this case (K) implies (S): If sugar is water-soluble, Zucky is water-soluble, too. But this is not valid the other way round: In a world with a different set of laws of nature, sugar might not have the disposition to dissolve in water, while Zucky might still be water-soluble for other reasons than being sugar.

Aside from things and kinds, a further candidate for the ascriptions of dispositions has been suggested by Nancy Cartwright: properties.[7] As Cartwright puts it – inspired by the second-order-property-view of dispositions:[8]

(P_C)   The molecular structure of sugar brings with it water-solubility.

In (P_C), one function of the phrase "the molecular structure of sugar" is to pick out what we are talking about: about the stuff having the molecular structure of sugar. Were this all there is to (P_C), we could render this statement as (P*):

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[7] Cf. Cartwright 1989 and 1999.

[8] For references for and criticism of this view of dispositions cf. Jansen 2004.

(P*)   Things having the molecular structure of sugar are water-soluble.

But in (P*) an important aspect is missing. According to the property-view, the property predicate in question has not only the function of picking out those things that are supposed to have a certain disposition, like in (P*), but the property is thought also to have a causal or explanatory function: those things posses this disposition, *because* they have that property. This explanatory function can be expressed in reduplicative sentences, i.e. in sentences containing phrases like "qua" or "in virtue of", like (P_R):

(P_R)   Things having the molecular structure of sugar are water-soluble in virtue of their having the molecular structure of sugar.

What Cartwright has in mind are types of properties. We can add tokens of properties, which are often called "tropes" or "abstract particulars"[9] as a further candidate:

(T_C)   This token of the molecular structure of sugar brings with it a token of water-solubility.

(T_R)   This token of the molecular structure of sugar brings with it a token of water-solubility in virtue of its being a token of the molecular structure of sugar.

Thus we exhaust the four-fold ontology Aristotle aims at in the second chapter of his "Categories":[10]

	PARTICULAR	UNIVERSAL
CONCRETE	individual **s**ubstances (this particular man)	universal **k**inds of substances (mankind)
ABSTRACT	individual property **t**okens (this particular red)	universal **p**roperty types (redness)

I will argue that disposition ascriptions to individual substances are the most basic kind. I want to reach this conclusion in four steps:

(1) I will argue that the ascription of dispositions to individuals substances is prior to the ascription of dispositions to kinds of substances (section 5.2),

(2) that disposition ascriptions to individual substances are prior to disposition ascriptions to individual property tokens (section 5.3), and

(3) that disposition ascriptions to universal kinds of properties are *not* prior to disposition ascriptions to individual property tokens (section 5.4).

(4) From this I will conclude, by transitivity of priority, that ascriptions of dispositions to individual substances are prior to ascriptions to any of the other ontological categories.

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[9] Discussion of and arguments for trope ontology can be found in, e.g., Macdonald 1998.

[10] For a modern defence of such a fourfold ontology cf. Lowe 2002.

5.2   Individual Substances versus Kinds of Substances

When I talk about a disposition ascription to a universal, I do not mean that there is some universal or platonic idea that has a capacity to be changed or to change itself. Rather, the ascription of a disposition D to a universal U means that anything that exemplifies U also possesses that disposition D. Not only does Zucky have the disposition to dissolve in water, but also sugar in general. Not only does Black Beauty have the disposition to digest hay, but horses in general. Now, which comes first, ascription to individual substances or disposition ascriptions to kinds of substances? I want to show that disposition ascriptions to individual substances are more basic in (1) metaphysical, (2) logical and (3) epistemological respect:[11]

(1) Metaphysical priority is not only an old,[12] but also a very useful concept, that can help to detect ontological dependencies. It can be tested by a simple contrafactual criterion: A is metaphysically prior to B, if A can be without B, but B cannot be without A. As I already mentioned, the truth of disposition ascriptions to individual substances is independent from the truth of the disposition ascription to the corresponding kinds. "Zucky is water-soluble" can still be true, even if "Sugar is water-soluble" were false, whereas it is not possible that "Zucky is water-soluble" is false while "Sugar is water-soluble" is true.

(2) The logical structure of a disposition ascription to individual substances is just the application of a predicate to a singular term, say "Wz" (with z = Zucky and "W" for "is water-soluble"). This was the kind of disposition ascriptions discussed in section 4. The logical structure of a disposition ascription to kinds of substances is more sophisticated. It might be considered to be a universal quantification over a conditional (with "S" for "is a chunk of sugar"):

$$(\forall x)\,(Sx \supset Wx)$$

The point is that the more simple structure of the disposition ascription to the concrete particular is embedded in the more complex structure of the universal disposition ascription. Thus you can explain a particular disposition ascription without reference to a universal disposition ascription, but not the other way round. Every universal disposition ascription contains the predication of dispositions to particulars.

(3) Disposition ascriptions to individual substances are also epistemologically prior to disposition ascriptions to kinds of substances. We could know a lot about the dispositions of individual substances without knowing the truth-value of any disposition ascription to a kind of substances. I may know that Enrico Caruso had the disposition to sing beautifully. I do not have to know any disposition ascription to kinds in order to have this piece of information about Caruso. This will not work the other way round. In order to know the truth-value of a universal disposition ascription to a kind of substance, we have to know a lot about the dispositions of individuals. In order to discover that humans can think, I first have to have acquaintance with several individual humans and learn about the thinking disposition of these individuals. Thus disposition ascriptions to individuals are epistemologically prior to disposition ascriptions to universals. We can conclude that disposition ascriptions to individual substances are prior metaphysically, logically and epistemologically to disposition

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[11] In showing this I give also reasons against the theory of disposition predicates proposed by Lowe 2001, who tries to reduce disposition ascriptions to concrete particulars to ascriptions of manifestation predicates to universals. In doing this, however, Lowe conflates the dispositional/categorical distinction with the distinction between predications to universals and predications to individuals.

[12] Cf. Aristotle, Categories 12, where Aristotle also mentions the contrafactual criterion that I employ for metaphysical priority. Aristotle tells us in Metaphysics V 11 that this criterion has already been used by Plato.

ascriptions to kinds of substances.[13]

5.3   Substances versus Property tokens

(1) What, now, about property tokens or tropes in comparison to individual substances? Well, recall (T_C):

(T_C)   This token of the molecular structure of sugar brings with it a token of water-solubility.

(T_C) cannot be true if my most favourite chunk of sugar is not water-soluble. For, if the molecular structure of sugar brings with it water-solubility, all bearers of this structure, i.e. all chunks of sugar, are water-soluble, a fortiori also Zucky.[14] But of course, Zucky may be water-soluble even if (T_C) is false, because the water-solubility may arise through some other property of Zucky. Thus it might be the case that the laws of nature change in such a way that (a) it is no longer true that Zucky's molecular structure brings with it water-solubility, but that (b) some other property of Zucky brings with it that disposition. Hence, disposition ascriptions to substances are metaphysically prior to those to tropes.

(2) The argument concerning logical priority recurs to the logical form of the propositions. But what, exactly, is the logical form of disposition ascription to tropes? If we consider (T_C), such an ascription poses a certain relation B ("brings with it") between two tropes, between a certain structure trope m and a solubility trope w:

$$B(m, w)$$

Hence, the logical structure of (T_C) seems to be totally different from the logical structure of (S): Here we have a two-placed relation applied to two tropes, there we have a one-placed predicate applied to a substance. It is only when we consider the semantics of B that we see an intimate connection. For "m brings with it w" obviously is meant to imply that m and w are tropes that belong to the same substance. Thus, "m brings with it w" means, roughly, that the thing that has m also has w out of, presumably, physical necessity. This phrasing, of course, features the predication of the disposition w to some substance in a prominent place. This points to the logical priority of disposition ascriptions to individual substances.

(3) Finally, disposition ascriptions to substances are also epistemically prior to disposition ascriptions to tropes because we can know a lot about the dispositions of individual substances without knowing anything about the tropes responsible for these dispositions. On the other hand, if we know that a certain trope carries with it a certain dispositional trope, then we already know that the substance to which the first trope belongs also has the disposition in question. Hence, disposition ascriptions to concrete particulars are prior to disposition ascriptions to abstract particulars, as well metaphysically as logically and

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[13] There is, however, an interesting kind of counterexamples, pointed out to me in discussion by Markus Schrenk. Of course, three-litre-cars have the disposition to drive 100 km by 3 litre petrol, and unicorns are said to have the disposition only to be caught by virgins. At present, there are no three-litre-cars, and there never were or will be unicorns. It seems as if we know these disposition ascriptions to concrete universals without knowing anything about concrete particulars. In the examples given (three-litre-cars, unicorns) this might be because some kind of apriori-knowledge is involved. However, these examples may also hint at the deeper insight that attributions to universals are not sufficiently represented by universally quantified conditionals. In Jansen/Strobach 2003 I hint at a possible alternative that construes ascriptions of predicates to universal as relations between concepts that are logically independent from ascriptions to individuals. I hope to work this out in more detail in a future paper.

[14] I assume, of course, that being a chunk of sugar is an essential property of Zucky, i.e. that Zucky is either a chunk of sugar of non-existent in any possible world.

epistemologically.

5.4   Property Types versus Property Tokens

The third pair I will compare with respect to priority are property types and property tokens.

(1) To begin with, what about metaphysical priority? Can a token m of a molecular structure bring with it a token w of a certain disposition when the respective disposition ascription to the structure type is false? It cannot, if the "brings with it" relation is meant to be stronger than a mere accidental co-occurrence in the same substance. Indeed, it is meant to express some stronger relation, as can be seen in the reduplicative phrasing: An M-thing is thought to be a W-thing *in virtue of* being an M-thing. I argued elsewhere that for a reduplicative sentence, i.e. a sentence containing phrases like "in virtue of" or "qua", three things have to be fulfilled:[15]

> x is F qua G is true if and only if (1) x is F, and (2) x is G, and (3) there is the correct conceptual relation R between F and G.

Now that conceptual relation – whatever it is supposed to be: conceptual implication, mutual implication, causal relevance etc. – has been shown not to be a statement about certain particulars alone, but a statement involving some kind of generality, either of a necessary, a factual or a statistical kind ("for the most part"). Thus such a statement about tropes already presupposes the respective statement about property types, because the statement is not meant to express a mere accidental relation.

What about the other way round? Can the dispositional statement about the property type be true if the respective statement about a trope is false? If the generality involved is of the "for the most part" kind, i.e. a mere statistical concept, this seems to be a metaphysical possibility. However, in an important respect this would be a quite unattractive position, as this leaves us in a position in which we cannot account for the fact that some tropes of that kind bring with them that disposition, but others do not. This would just be inexplicable. If, on the other hand, the generality involved is a genuine one, no exceptions are allowed, and thus the truth of the statement about the trope is implied by the statement about the abstract universal.

To sum up: The ascription of dispositions to property types and tropes are stronger intertwined than the other cases discussed. According to the contrafactual criterion used so far, neither is metaphysically prior to the other.

(2) What about logical priority? In section 5.3, I represented the logical structure of the disposition ascription to tropes as claiming a certain relation B ("brings with it") between two tropes, i.e. as "B(m, w)". Accordingly, the logical structure of the ascription to property types might be something like the following:

$$(\forall x)(Mx \supset (\exists y)(Wy \ \& \ B(x, y)))$$

Here, the disposition ascription to tropes (i.e. "B(x, y)") is a central feature of the logical structure of the disposition ascription to property-types. Hence, if this analysis is correct, disposition ascriptions to abstract particulars are logically prior to the disposition ascriptions to abstract universals.

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[15] Cf. Jansen 2002, 43.

(3) What about epistemological priority? Here again, it is important that the "brings with it" relation is thought to be stronger than a mere accidental concurrence. Therefore, as soon as we know that a certain property token m as such is responsible for a certain disposition token w, we know that also the respective property type to which m belongs is responsible for the property type to which w belongs. And, of course, because of the involved generality of the disposition ascription to the property type, we know that the respective disposition ascription also applies to the tokens of that type. Hence, tropes and property types are on equal footing with respect to epistemological priority.

5.5   Substances versus Property Types

Now disposition ascriptions to tropes are logically prior to disposition ascriptions to property types and on equal footing with them with respect to both metaphysical and epistemological priority. Disposition ascriptions to substances, in turn, are prior to disposition ascriptions to tropes in all three respects, as I have argued before. Hence, by transitivity of priority, disposition ascriptions to substances are also prior to disposition ascriptions to property types in all three respects. Thus the most basic kind of disposition ascriptions – metaphysically, logically, and epistemologically – are dispositions ascriptions to individual substances.

6. Evidence: When Do We Ascribe Dispositions?

6.1 Ascription of Surefire Dispositions to Individuals

Finally, I want to discuss the question of evidence: When do we ascribe dispositions? I will first discuss the predication of surefire dispositions to individuals. This case is simple in two respects: First, it leaves out probabilistic dispositions and deals with surefire dispositions only, i.e. such dispositions that lead invariably to their manifestations in given circumstances. Second, it takes only predication to individuals into account, and leaves out predication to universals. Thus, we have two twofold distinctions yielding four cases that are to be distinguished: (a) ascriptions of surefire dispositions to individuals, (b) of surefire dispositions to universals, (c) ascriptions of probabilistic dispositions to universals, and (d) of probabilistic dispositions to individuals.

I will first discuss the simple case of ascribing surefire dispositions to individuals and turn to the other cases in the following subsections. I will base my discussion on the following plausible assumption on the relation between surefire dispositions and their manifestations, the *principle of manifestation*.[16] Indeed, fulfilling this principle is just what it is to be a surefire-disposition:

> If x has the surefire disposition D to display-M-in-circumstances-C and x is situated in circumstances C, then x will display M.

With this principle and the assumption that a certain disposition D to display M in circumstances C is indeed a surefire disposition, the following three propositions are not jointly compatible:

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[16] In fact, this assumption has already been formulated by Aristotle in Metaphysics IX 7. A discussion of this passage can be found in Jansen 2002, chapter 5. In what follows I suppress time-indices; for a discussion of the temporal relation of dispositions to their manifestations cf. also Jansen 2002, chapter 5.

(D1)	Dx	(x has disposition D to display M in circumstances C.)
(D2)	Cx	(x is situated in circumstances C.)
(D3)	¬Mx	(x does not display M.)

This observation gives rise to two different research strategies for disposition ascriptions:

(1) The first strategy takes C to be a known finite string of conditions, fixed either by observation or by definition. This strategy will then try to realise this set of conditions C, i.e. (D2) is made true. In that case, it is not possible for both (D1) and (D3) to be true. Thus, if the manifestation does not happen, i.e. if (D3) is true, then (D1) cannot be true, i.e. x cannot have the disposition D to display M in circumstances C. If we have evidence of such a kind as produced by this research strategy, we cannot rationally ascribe disposition D to x. Thus, this strategy is a method to falsify disposition ascriptions.

(2) The second strategy starts out agnostic about (D2), but is dogmatic about the truth of (D1): We assume that D is just that disposition, that is being possessed by x, and the task is, to find out more about the circumstances for which D allows x to display M. If we follow this strategy, we realise some set C* of conditions. If x does not display M, then (D3) is true. Thus, (D2) must be false, which in turn implies that, in fact, x is not yet situated in circumstances C, i.e. that C* is not C. This research strategy is no strategy for a straightforward falsification of a disposition ascription. What is being falsified here are hypotheses about the circumstances, in which D will manifest itself.

There is another plausible principle about dispositions, which yields a third research strategy. Whereas the other two research strategies are strategies to falsify disposition ascriptions, this third strategy allows the verification of certain disposition ascriptions. The underlying principle gives us positive reasons to ascribe dispositions. I call it the *principle of enabling*:

If x displays M in circumstances C, x must have had the disposition D, which allows for a manifestation M in circumstances C.

Thus, (3), if we have empirical evidence that x is both in C and is displaying M, we can infer that x has the disposition D to display M in circumstances C. This is, how we can verify a disposition ascription. Of course, the evidence for D can be only as strong as the evidence we have for C and M. But this is a problem of empirical reasoning in general, not a problem special to dispositions. If Zucky dissolves in water, it must have had the disposition to dissolve in that liquid in the first place. If a compass needle orients itself to the north, it must have the disposition to do so.

Sometimes, however, we will have difficulties to find out, *whose* disposition is at work. If John swallows a pill, and his headache pain is relieved after that: was it really a disposition of the pill that did the work? Maybe the pill was of no causal relevance at all, and it was the water with which he took the pill, or the swallowing, or the beautiful sunshine, or some other feature of this situation. As a rule, this problem occurs with all *active dispositions*, i.e. with dispositions of things to cause a change or a process to occur in other things. With *passive dispositions* this problem does not occur. For passive dispositions are dispositions of things to suffer changes. Thus by definition the passive dispositions always are in the things that undergo a change or a process. The bearer of the active disposition, on the other hand, is not so easily known. This is something that has to be detected by empirical science.

6.2 Ascription of Surefire Dispositions to Universals

Science is in general not so much concerned with disposition ascriptions to individuals but with generalised statements, with disposition ascriptions to universals. Scientists do not so much want to know whether Zucky is water-soluble or not, but whether sugar is. They do not care whether Black Beauty can digest hay, but whether horses have this disposition. Of course, the evidence used by scientists may consist in disposition ascriptions to individuals. But what is printed in the textbooks are generalised statements, or disposition ascriptions to universals. That Black Beauty can digest hay will not appear in any biology book. What we learn in biology is that all horses digest hay – or, in short, that horses digest hay, and in chemistry, that (all) sugar dissolves in water. It is an old and still intriguing problem how universal sentences like these can be justified empirically. But this is a general problem of all empirical research, and not a problem that is particular to disposition ascriptions.

6.3 Ascriptions of Probabilistic Dispositions to Universals and Individuals

So far I discussed surefire dispositions only, because the principle of manifestation, by definition, is only valid for these dispositions. Of course, there may also be other kinds of dispositions. I will call such non-surefire dispositions "probabilistic dispositions", because they bring about a certain probability for a manifestation. At times, they are also called "propensities".[17] Probabilistic dispositions bring it about that their bearer will react with such-and-such a probability under such-and-such conditions in such-and-such a way. As the manifestation is only probable, a missing manifestation M in a given situation is no evidence for the lack of a propensity to manifest M in this situation. On the contrary, there may be a high probability for M, although by chance no manifestation will arise. A *probabilistic variant of the principle of enabling* is still valid for propensities, though:

If x has the propensity D_P to display M in circumstances C with probability P, and if x is situated in circumstances C, then x will display M with probability P.

Of course, this variant is much more undetermined. Any non-manifestation of M might be compatible with the ascription of a propensity D_P for M, for $0 < P < 1$. And a single manifestation of M does not tell us anything about the probability with which M occurs. To test such probabilities, we therefore need numerous series of observations and experiments. For example, we may observe the behaviour of a huge number of atoms of, say, a certain uranium isotope and determine the time it takes till half of these atoms have decayed. In this way we determine the half-life period of this isotope. We have thus established that atoms of this isotope have the disposition to decay with a probability of 50 % within this stretch of time. This disposition is, to my knowledge indisputably, not a surefire disposition. It is an example for a genuine probabilistic disposition.

There may be other cases, where genuineness may justly be disputed. Tests show that only a certain number, say *n* out of hundred people, will taste something if a probe of rat-poison is put on their tongue. Now, is there any disposition we can universally ascribe to humans? Do humans have the probabilistic disposition to taste rat-poison with a success rate of *n* %? Such a disposition ascription will not explain why always the same people do or do not taste the rat-poison. What we are likely to say in this case is that *n* % of humans have the surefire disposition to taste rat-poison while the rest of the human population is lacking this

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[17] Cf., e.g., Popper 1990. For a detailed discussion of theories of objective probabilities cf. Rosenthal 2003.

disposition. Thus not every statistical result is eligible for postulating a genuine probabilistic disposition.

Another example: Most medical tests yield only statistical results. Do these tests establish genuine probabilistic disposition ascriptions? I would say they normally do not. Aspirin, for example, is said to cure headaches. But aspirin cannot in all cases be applied successfully; it fails in, say, m % of all cases. We may be tempted to explain these failures by attributing a probabilistic disposition. For the case of aspirin is in an important respect different from the case of rat-poison-tasting humans: While human beings differ quite a lot from each other, aspirin pills are thought to be equal in all causally relevant respects. In this they seem to be like atoms of the same isotope. Thus all aspirins should have the same dispositions, and these seem to be probabilistic ones. But if aspirin had the probabilistic disposition to cure headaches in $(100 - m)$ % of all cases, this would not explain why there are patients where aspirin always fails to cure the headaches, while it is almost always successfully applied to others. Let us explore the story further: To cure headaches, aspirin has to connect to certain chemical receptors within the human body. And certain people, it is said, do not have these receptors because they have certain deviant genes. Thus it is nothing within the individual aspirins themselves which makes them work at one time and fail at another. It is just that aspirins do not have the disposition to cure headaches without any further qualifications, but, as we should have expected, only the disposition to cure them under certain circumstances. What aspirins do or do not cause depends on who swallows them. Again, we have a mere statistical result and no genuine probabilistic disposition. Aspirin has the surefire disposition to cure headaches under conditions C; it only happens that conditions C obtain in only $(100 - m)$ % of all cases.

We see that not every statistical result is evidence of genuine probabilistic dispositions. In many cases we just have individuals with different causally relevant properties. In other cases we have individuals that share all causally relevant properties, but the necessary manifestation conditions do not always obtain. The only case that is of interest for the ascription of genuine probabilistic dispositions is if individuals with the same causally relevant properties behave differently though all necessary manifestation conditions are obtaining.

7. Conclusion

By way of conclusion, I will sum up the results reached in this paper. Disposition ascriptions occur both in daily and scientific contexts. They can contain action related information and may lead to scientific explanations. Often, disposition ascriptions are elliptical. Communicational success about disposition ascriptions is possible, because the context of utterance supplies the information necessary for disposition ascriptions that are thought to give action-related information. This is not an option for science: Scientists, therefore, should make as explicit as possible what manifestations they are talking about and in which circumstances these manifestations are supposed to be displayed. We can ascribe dispositions both to particulars and to universals, to concrete and to abstract things. However, disposition ascriptions to concrete particulars, i.e. to Aristotelian substances, are the most basic kind: They are prior metaphysically, logically and epistemologically to disposition ascriptions to any of the other three ontological categories. The principle of manifestation and the principle of enabling provide a variety of strategies to verify or to falsify disposition ascriptions, though special precautions have to be observed in the case of probabilistic dispositions.

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