

Published in: Dubitzky, W./ Wolkenhauer, O./ Cho, K.-H./ Yokota, H. (2013) (eds.): *Encyclopedia of Systems Biology*, Vol. X. New York: Springer, 594-597.

## Disposition

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### Synonyms

potentiality, tendency, power, capacity

### Definition

Dispositions are properties that need enabling conditions for being manifest.

### Characteristics

#### (1) Dispositional vs. categorical properties

Properties of objects or systems ([system](#), [complex](#)) are usually distinguished into dispositional properties and categorical properties. Everyday paradigm cases of dispositional properties are, for instance, courage and fragility; paradigm cases of categorical properties are shape and structure of an object or a system. Whether it is possible to explicitly define individual dispositions (and to provide a general definitional scheme for 'disposition' as a generic term) is a major dispute in the debate about dispositions (see sect. 3).

In the case of dispositional properties it is important to distinguish between an object or system having a property on the one hand and manifesting the property under enabling conditions on the other. A person may be a courageous person all his life but has only few occasions to show courageous behavior. Similarly, a glass may be fragile but this disposition will become manifest (i.e. the glass will break) only if given certain enabling or stimulus conditions obtain (e.g. striking of the glass). On the contrary, if objects or systems possess categorical properties (e.g. the roundness of a billiard ball) they will be manifest unconditionally. Thus, concepts for categorical properties do not entail the distinction of having the property and manifesting it.

Many examples of dispositional properties can be found in the biological sciences. The capacity of amino acid chains to fold into a specific three-dimensional

structure, the capacity of genes to become activated, the ability of muscle fibers to contract, the pluripotency and totipotency of cells, the fitness (capacity to reproduce successfully and survive) of organisms, the evolvability/adaptability of populations, and the sustainability of ecosystems are just a few of several examples which could be mentioned here.

## **(2) The importance of dispositions for science**

Dispositions have been controversial since early modern times because they were conceived of as hidden causes (**causality**) that bring about effects (their manifestations). Molière in his *Le Malade imaginaire* ridicules explanations (**explanation, biological**) in terms of dispositions by pointing out that one might explain why opium puts people to sleep by appealing to its 'dormitive virtue'. However, it is explanatory empty to refer to hidden causes that are epistemically accessible only via a single effect.

However, since the 1930s (Carnap 1936) it became apparent that dispositional concepts do play an important role in science and furthermore interest in dispositions as an analytical tool for characterizing science has resurged considerably in the last two decades (Mellor 2000, Fara 2006). The concept of a disposition is an important tool in the analysis of science because it points to the fact that the properties/behavior of systems may only be manifest given certain enabling or stimulus conditions, e.g. contextual factors. This is particularly true in the biological sciences. We attribute many properties to biological systems (e.g. the ability of muscle fibers to contract) that become manifest only given the presence of specific enabling conditions (e.g. the presence of ATP and an appropriate stimulus).

## **(3) Conditional Analysis**

Certain aspects of dispositions have been debated (see Mumford 1998 for a comprehensive overview). We will discuss some of these issues in order to clarify what is implied by the attribution of a disposition to an object or a system (**system, complex**).

First, what are the conditions under which we can legitimately attribute a disposition D to a system s? To give a precise answer to this question requires specifying the relation between having a disposition and manifesting it. One major issue in the debate about dispositions is whether this connection can be made more precise – whether particular dispositions can be defined explicitly in terms of their manifestations and enabling conditions.

The starting point for such attempts is the so-called simple conditional analysis. Let Ds stand for system s having the disposition D, that is, s being disposed to M (manifestation) provided enabling conditions E obtain. According to the simple conditional analysis (SCA) the necessary and sufficient conditions for s having D can be symbolized as follows:

SCA:  $Ds \leftrightarrow (Es \rightarrow Ms)$

which is to be read as: s has Disposition D if and only if: If s were confronted with E then s would necessarily manifest M. Thus, given SCA and given we know how to test the counterfactual claim " $Es \rightarrow Ms$ " we know under which conditions we can legitimately attribute D to s.

One problem with the SCA is that manifestations cannot easily be specified. What exactly are the manifestations of being courageous or of fragility (cf. Prior 1985, 6-10)? Likewise, it is difficult to spell out the exact enabling conditions for a disposition (e.g. breaking, hitting, and throwing in particular ways). This is even truer for biological dispositions because the way in which the context is involved in the manifestation is diverse and complicated, and the enabling conditions are very complex.

Another significant problem for the simple conditional analysis is a family of counterexamples that shows that the right hand side of SCA ( $Es \rightarrow Ms$ ) is neither necessary nor sufficient for the left hand side (Ds). There are various such counterexamples discussed under the headings of 'antidotes', 'finks', 'masks' etc. For example, if we understand 'fatally poisonous' as 'disposed to kill if ingested'. Someone might take the poison but nevertheless survive because of some antidote that has been ingested as well (Bird 2007, 27). In such a case the substance is fatally poisonous but the manifestation does not take place even though the enabling conditions (ingestion) did occur. A fortiori the right hand side of SCA is not a necessary condition for the left hand side. There are possible interferences, which invalidate SCA. Thus, the manifestation of a disposition requires not only enabling conditions but also the absence of interfering factors. Only if all of these conditions can be listed explicitly, the SCA would provide an explicit definition of a dispositional concept. It is, however, a controversial issue whether it is even in principle possible to list all relevant factors. Take the example of the differentiability of cells. The process of manifestation, that is, the differentiation of a cell into a specific cell type is a very complex and temporally extended process, which requires that many genes are correctly activated or repressed, that plenty of proteins are properly synthesized and interact in the right way with each other. According to the [complexity](#) of the differentiation process numerous factors could disturb this process and prevent the manifestation. It is hardly imaginable that one could (even in principle) prepare a complete list of all possible interfering factors.

#### **(4) Intrinsicity**

A second instructive debate concerns the intrinsicity of dispositions. Roughly speaking, a property is intrinsic if a system possesses the property independently of what is going on in its context. Shape is an intrinsic property, whereas being smaller than everybody else in the room is an extrinsic (relational) property.

The rationale for attributing a disposition to a particular system seems to imply that dispositions are intrinsic. The rationale is as follows: The phenomenon of sugar dissolving in water is - strictly speaking - a property of a combined system – sugar plus water. If we describe the phenomenon in terms of a disposition being manifest rather than in terms of a property of a compound system, we usually introduce a distinction between a system (e.g. sugar), which is endowed with a disposition, and external, e.g., contextual conditions. If we ascribe solubility to sugar then we focus on those conditions for the obtaining of the phenomenon that are due to the sugar only. The disposition (solubility) comprises exactly those conditions of the phenomenon that the system (sugar) possesses independently of what is going on in the context. Thus, even though the manifestation of dispositions (e.g. the dissolving in the case of solubility) depends on extrinsic factors it is usually held that the disposition itself (e.g. the solubility of salt) is intrinsic. But intrinsicity may not be a necessary feature of dispositions (cf. McKittrick 2003; Fara 2006, sect. 4). The challenge is particularly clear in the case of some biological systems: The importance of the context undermines the claim that all dispositional properties are intrinsic. As Alan Love (2003) has pointed out for the example of the evolvability of populations ([adaptation](#)), in many cases external factors are not only the enabling conditions for biological dispositions. Rather, they determine jointly with intrinsic factors the very nature of the disposition as well as its causal efficacy. For example, whether a population is evolvable or not is not independent of contextual factors like migratory abilities and landscape topography. Hence, the intrinsic character of the biological disposition 'evolvability' is called into question.

##### **(5) Single-track vs. multi-track dispositions**

Courage, it seems, is a disposition that will be manifested in different situations by different behavior. It is a multi-track disposition; that is one disposition with multiple possible manifestations. However, the SCA-tradition has often assumed that dispositions are individuated in terms of one set of enabling conditions and one manifestation (single-track dispositions). The drawback is a proliferation of dispositions, e.g. different courage-dispositions – one for each kind of courageous behavior, e.g. courage in the face of death and courage in the face of financial stress.

In biology there are many possible candidates for multi-track dispositions: The manifestation of evolvability for a population can result in different changes of gene frequency of a population; the pluripotency of stem cells can become manifest in muscle cells, bone cells etc. But on closer inspection it becomes apparent that the characterization of these dispositions as 'multi-track' depends on a fine grained analysis of the manifestation states. If we raise the graininess of the analysis, just one and not multiple possible manifestation states can be identified. For example, the evolvability of a population will be manifest if its gene frequency has changed

independent of the kind of gene whose frequency has changed and independent of the exact dimension of the change.

## **(6) Reduction**

A further frequently disputed question concerns the issue of **reduction**. Dispositions such as fragility are necessary conditions for the obtaining of the manifestation (provided the simple conditional analysis or something akin is correct). This is often analyzed as: Fragility is causally efficacious (**causality**) in bringing about the manifestation. An ensuing question that has been widely discussed is whether a disposition can be considered causally efficacious on its own or whether it is causally efficacious in virtue of an underlying causal basis, such as molecular structure.

It is important to distinguish two issues in this debate. First, fragility and other every-day dispositions are macroscopic properties. We tend to assume that macroscopic properties of systems can be reduced to their molecular structure. A glass for, instance, is fragile in virtue of its molecular structure. This, however, is true for dispositional and categorical properties alike. The glass has its shape (a categorical property) in virtue of its molecular structure (and/or arrangement) as well. So this is not special issue for dispositions.

A second, different, issue is whether there can be bare dispositions or whether every dispositional property needs to be reduced to categorical properties, such as the micro-structural configuration. The question is whether there might be irreducible dispositional properties that cannot be identified with a set of categorical (e.g.) micro-structural properties. The physical property 'charge' or other fundamental dispositions might be candidates for bare dispositions because there are no micro-structural properties that they might be identified with.

## **Cross-references**

adaptation; causality; complexity; explanation, biological; reduction; system, complex

enabling conditions; evolvability; intrinsicity; manifestation; Simple Conditional Analysis (SCA)

## **References**

- Armstrong DM, Martin CB, Place UT (1996) Dispositions – A Debate, Routledge: London
- Bird A (2007) Nature's Metaphysics: Laws and Properties. Oxford University Press: Oxford
- Carnap R (1936) Testability and Meaning. Philosophy of Science 3: 420–471

- Fara M (2009) Dispositions In: Zalta EN (ed) The Stanford Encyclopedia of Philosophy (Summer 2009 Edition).
- Love A (2003) Evolvability, Dispositions, and Intrinsicity. *Philosophy of Science* 70: 1015–1027
- McKittrick J (2003) A Case for Extrinsic Dispositions. *Australasian Journal of Philosophy* 81: 155–174
- Mellor DH (2000) The Semantics and Ontology of Dispositions. *Mind* 109: 757–780
- Mumford S (1998) *Dispositions*. Oxford University Press: Oxford
- Prior E (1985) *Dispositions*. Aberdeen University Press: Aberdeen