

Zooming through system levels

The proper-parthood relation PPpw is spread out between system levels, such that all the whole-constituting parts p and their relations are collected on, say, level n-1 in a container, the “holon”, while the constituted whole w is placed on level n, above. This is repeated for all levels. Multiple application of the principle of transitivity yields **PPp(0)w(n)**, valid for all n. It means that all levels will contain the same basic constituents, p(0), levels are *identical* in composition to 0-level. Hence they adjust synchronic to a change in 0-level, the much-discussed additional coupling by inter-level relations, causal or constitutive, is superfluous. Yet levels differ significantly, as will be discussed.

1. The epistemic whole:

The world consists of a large number of complex objects and relations, while the working memory of our brain can handle only few items at once.¹ To manage this obvious shortcoming, we lump functionally related items (components) together into “wholes”. These palatable chunks arise out of epistemic necessity and are referred to with names acting as symbols or shortcuts. For instance, the 10000 or so atoms and biochemical groups of atoms of a certain function are cursory referred to as a “receptor molecule” or perhaps “D2” in case of a type-2 dopamine receptor.

It is understood that the “whole” (the whole receptor molecule) is constituted of many parts, i.e. of the 10000 or more atoms essential for the receptor function. With the number of parts > 1 , the proper-parthood relation of mereology applies.^{2 3} It is asymmetric:⁴

$PPpw \wedge \neg PPwp$ // every p is a proper part of w, and asymmetry.

Every whole is necessarily in *constitutive relation* to its components and parts, meaning that w is constituted by them, their properties, relations and interactions. The *constitutive* relation CR is a special case of the proper-parthood relation:

$CRpw \wedge \neg CRwp$, // w is constituted by all proper parts p (their properties, relations and activities) and by nothing else. Further, since p is not constituted of w, there is no constituting effect or change extending from w to p.

The asymmetry means that, given a constitutive whole, there can be no constitutive influence directed from whole (receptor) to proper part. There is no 'mutual manipulability' of whole and parts,

1 Miller, G.A., *The magical number seven plus or minus two: Some limits on our capacity to process information.* Psychol. Rev., 1956. **63**(2): 81-97

2 e.g. Kim, J., *Supervenience*, in *A Companion to the philosophy of mind*, S. Guttenplan, Editor. 1994, Blackwell: Oxford. p. 575-583.

3 Lindemann, B., *A whole affects its parts? Bottom-up and top-down changes reconsidered*, 2015, invocov-verlag. 64 pages, p.17.

4 The properties of PP are: Transitive, asymmetric and hence irreflexive. See: Koslicki, K., *The Structure of Objects*. 2010, Oxford: Oxford University Press. 312 pages. p.11.

manipulations are directed from p to w only.

2. Road-map:

To elaborate on the above example, a biochemical receptor is kinetically modelled as a mechanism which assumes a finite number of mutually exclusive states. The transitions of states are collected in a state-transition diagram. It is a “road-map”, in part cyclic,⁵ which stipulates the kinetic *properties* of interacting components (parts) like atoms or biochemical groups. Further, there are always over-componential properties like “reaction rate” or “speed of contraction” or “turnover” which cannot be attributed to single components or to the sum of single-component interactions. Aristotle famously referred to such over-sum properties with “A whole is more than the sum of its parts”. The over-componential properties and emergent properties result from the concerted *bottom-bottom* interaction of components, restricted to causal chains and networks by the “structure” of the system.⁶

3. System levels:

When combining mereological parts-whole relations with hierarchical system structure, variables are assigned to levels, creating the directions *bottom-up* and *top-down*.⁷ For instance, the proper-parthood relation PPpw may be spread out between system levels, such that all the whole-constituting parts p with their relations and interactions are found on levels < n in a separate space, the “holon” (Koestler's wording).⁸ The constituted whole w is found on level n, above. Thus w becomes w(n) and p becomes p(< n), with the parts always below the level of the whole. The proper-parthood relation becomes Ppp(n-1)w(n) or, more generally, Ppp(< n)w(n).

Let a system consist of a hierarchy of levels labelled societies (n=8), organisms (n=7), organs (n=6), networks of cells (n=5), cells (n=4), subcellular organelles (n=3), molecules (n=2), atoms (n=1), subatomic particles and waves (n=0). In this system the proper-parthood relation applies across all levels. Multiple application of the principle of transitivity yields:

$$\begin{aligned} Ppp(n-1)w(n) \wedge Ppp(n-2)w(n-1) &\rightarrow Ppp(n-2)w(n) \\ Ppp(n-2)w(n) \wedge Ppp(n-3)w(n-2) &\rightarrow Ppp(n-3)w(n) \\ \dots &\rightarrow \mathbf{Ppp(0)w(n)} \end{aligned}$$

Repeating this for all values of n, we obtain the relations which define our system of 8 levels:

$$Ppp(0)w(1), Ppp(0)w(2), \dots Ppp(0)w(8).$$

Similarly, for a constitutive relation the result is CRp(0)w(n). In both cases an item p at 0-level is part of all other levels. Hence all levels have the particle and wave content of the zero-level. Therefore all levels will adjust synchronic to an interactive change arising at the 0-level. The argument by transitivity, as proposed above, allows the significant conclusion that the levels of a parts-whole system are ideally coupled by identity and will adjust together.⁹

5 Hill, T.L., *Free Energy Transduction in Biology. The steady-state kinetic and thermodynamic formalism*. 1977, New York: Academic Press. 229 pages.

6 Structure: All relations displayed in the state-transition diagram. Note that “parts and their relations” includes all over-componential properties and property-emergences of the holon in question, as these, too, are constitutive for the whole!

7 *Bottom-up* is the direction $p \rightarrow w$, *top-down* the direction $w \rightarrow p$.

8 Koestler, A., *The ghost in the machine*. 1967, London: Hutchinson 1967 or Arkana Penguin Books 1989. 384 pages. and more formally Bertalanffy, L.v., *General System Theory*. 1969, New York: George Braziller. 296 pages.

9 The 'synchronic adjustment by identity' appears to be a general property of parts-whole systems, including the 'levels of mechanisms' considered by Craver, C.F., *Explaining the brain. Mechanisms and the mosaic unity of*

Yet the objects displayed and their arrangement is different: Levels differ in magnification or grouping of 0-level objects and by the assignment of symbols to the groups. They differ further in the level-specific idiom and in the 'laws' describing objects and events with this idiom.¹⁰

4. Horizontal interaction and vertical identity:

On all levels $< n$ components (are said to) engage each other causally by a time-consuming process of physical and chemical interaction with peers. This is known as *horizontal* or intra-level interaction.¹¹ However, such interaction is strictly possible only for mereological atoms, which have no parts, thus are items of the 0-level.¹² Therefore the problem disappears when with Pp(0)w(n) the 0-level is reached (see preceding section).

Coupling of adjacent system levels is known as *vertical* or inter-level coupling. Options to be discussed are

- (a) upward causal, (b) upward and downward causal,
- (c) upward constitutive, (d) upward and downward constitutive,
- (e) identity with zero-level.

(a) and (b) can be excluded because a whole cannot be separated from its parts, therefore cannot encounter its parts for interaction. Thus the much-discussed *downward causation*¹³ is not possible.

(c) and (d): According to Craver and Bechtel the constitutive relation is responsible for vertical coupling of levels of mechanisms. Both the *bottom-up* and the *top-down* branch was claimed to effect this coupling.¹⁴ Yet, participation of the *top-down* branch and 'mutual manipulability' of whole and parts of mechanisms is to be denied, because the constitutive relation, like the proper-parthood relation, is asymmetric, *bottom-up* only.¹⁵

A denial of a causal part-whole interaction between levels¹⁶ and my denial of constitutive influences directed from whole to parts¹⁷ is contrary to the opinion of many classical and modern authors in science and philosophy.¹⁸

The remaining option is (e). Here vertical coupling of levels by options (a) – (d) is superfluous due to the basic *identity* of levels, as proposed above.¹⁹

neuroscience, 2007, New York: Oxford University Press. 308 pages. p.188.

10 They resemble the 'levels of nature' discussed by C.F. Craver. See W. Wimsatt (1976) and Figure 5.6 in Craver, C.F., 2007, l.c.

11 Craver, C.F., 2007, l.c. p.236.

12 In a hierarchical parts-whole system parts which are constituted of parts, cannot interact horizontally as wholes with peers, because wholes are fully and exclusively constituted by their parts. e.g. Lindemann, B., *Mechanisms in World and Mind*. 2014, Exeter, UK: imprint academic. 152 pages. Page 28. and Lindemann, B. 2015, l.c. page 12.

13 Andersen, P.B., et al., eds. *Downward Causation. Mind, Bodies and Matter*. 2000, Aarhus University Press: Aarhus. 354 pages.

14 For the claim of 'mutual manipulability', see Craver, C.F. and W. Bechtel, *Top-down causation without top-down causes*. *Biology and Philosophy*, 2007. **22**: p. 547-563., and Craver, C.F., 2007, l.c. p.153.

15 Lindemann, B., 2015, l.c. p. 20.

16 Craver, C.F., 2007, l.c. p. 195.

17 Lindemann, B., 2015, l.c. p. 22.

18 e.g. see Craver 2007 in his chapter 5 "A field-guide to levels", p.163. Also see Lindemann, B., 2015, l.c., p.10,11

19 Lindemann, B., 2014, l.c. p.37.

5. Zooming in and out:

Scale: System levels differ basically in the detail displayed or hidden, in the degree of zoom. When we want detail and mechanistic explanation, we zoom in *top-down* on the small, neglecting for the moment the overview.²⁰ When we want the overview, we zoom out *bottom-up*, surveying the large, neglecting unwanted detail, thereby advancing from molecules to organelles to cells, or from organisms to populations, and so on.

No inter-level effects: The system levels, like identical clones, have the same content, that of the 0-level, they are ideally 'coupled by identity'. By identity an event at the 0-level will always appear synchronic on all levels. No additional inter-level relation of coupling, be it causal or constitutive, is needed.

Epistemic advantage: Why do we need system levels? One reason is that they order complex world phenomena into palatable wholes, adjusting to our cognitive ability, which is limited. By a bottom-up neglect of detail we replace complex events symbolically with a series of wholes, which are ordered hierarchically in levels, thus reducing the number of items to be raised into consciousness and held in working memory for processing. Such economy of representation will extend the range of problems which can be tackled by our cognitive brain.

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²⁰ The zooming-in is the main step towards 'reduction' and 'reductive explanation'.