Does Biology Need a New Theory of Explanation?

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So what's the difference between a description and an explanation?

- Can we get away without explanations?

So What's the Problem?

- *But suppose that causality, for its past, is veiled in darkness with respect to what it is? Certainly for centuries we have acted as though the doctrine of the four causes had fallen from heaven as a truth as clear as daylight. But it might be that the time has come to ask, Why are there just four causes? In relation to the aforementioned four, what does 'cause' really mean? From whence does it come that the causal character of the four causes is so unifiedly determined that they belong together? (Heidegger, The Question Concerning Technology,1962).*

Pre-Aristotelian explanations of nature

- The *Physikoi* - e.g. Anaximander, Heraclitus, Hippocrates, Pre-Homeric Greeks
- Explanations based on the notion of *Phusis*
- Inherently dynamic, [e.g. a flower blooming, or a caterpillar transforming into a butterfly]
- *Phusis* as a notion captured the origin, process, and result of nature in a different way to current notions of causality
- In many cases (for Monists such as Thales) it also carried with it the concept of hylozooism, that is that matter is literally alive
- For more see Naddaf - The Greek Concept of Nature (2005)

Aristotelian Causality Summary -

- **Material** - That out of which a thing ‘comes to be’ [The ‘out of what’]
- **Formal** - The patterning, ordering, structure, organisational properties [The ‘into what’]
- **Efficient** - The primary source of the change or rest [‘From what’]
- **Final** - The end, that for which the sake of which a thing is done [For what, or towards what’]

As an example for an artefact, such as a house

	A question	Explanation
Material Cause	Out of what?	Wood
Formal Cause	Into what?	A particular shape of house
Efficient Cause	From what?	The builder
Final Cause	For what, or towards what?	To provide shelter

As an example for an organism, such as a tree

	A question	Explanation
Material Cause	Out of what?	Wood
Formal Cause	Into what?	The shape or form of a tree, the kind of thing the wood constitutes.
Efficient Cause	From what?	A fully developed tree of the same kind, at the end of generation. That which produces the tree
Final Cause	For what, or towards what?	To continue the existence of the species. The movement towards that which is best for the animal. That which it develops into

David Hume

- 1739 - A Treatise of Human Nature
- Reduced Aristotelian Causality to a version of efficient cause based around mechanistic philosophy

Introducing Kant's Critique of Teleological Judgment 1790

- Kant's concern - Organisms seem to have a 'purposiveness' that is similar to a teleological causality rather than mechanistic.
- Mechanistic explanations are useful, but miss an essential 'intuited' nature
- But… Teleological explanations have the problem of a 'designer', and working backwards in time… and don't seem to be 'good science'

How Kant saw nature

Summary of Kant's types of explanation		
	Example	Our Understanding
Efficient Causal	Mechanical aggregates (e.g. rocks)	Empirical
Formal Purposiveness	Hexagon	A Priori
Designed Purposiveness	House, Art	External to the artefact
Natural Purposiveness	Organisms	Internal, (ends and means in itself)

Mechanism

- Mechanism is the belief that natural wholes (principally living things) are like machines or artifacts, composed of parts lacking any intrinsic relationship to each other, and with their order imposed from without.
- The source of an apparent thing's activities is not the whole itself, but its parts or an external influence on the parts.
- In the mechanistic view organisms are fundamentally no different to machines.

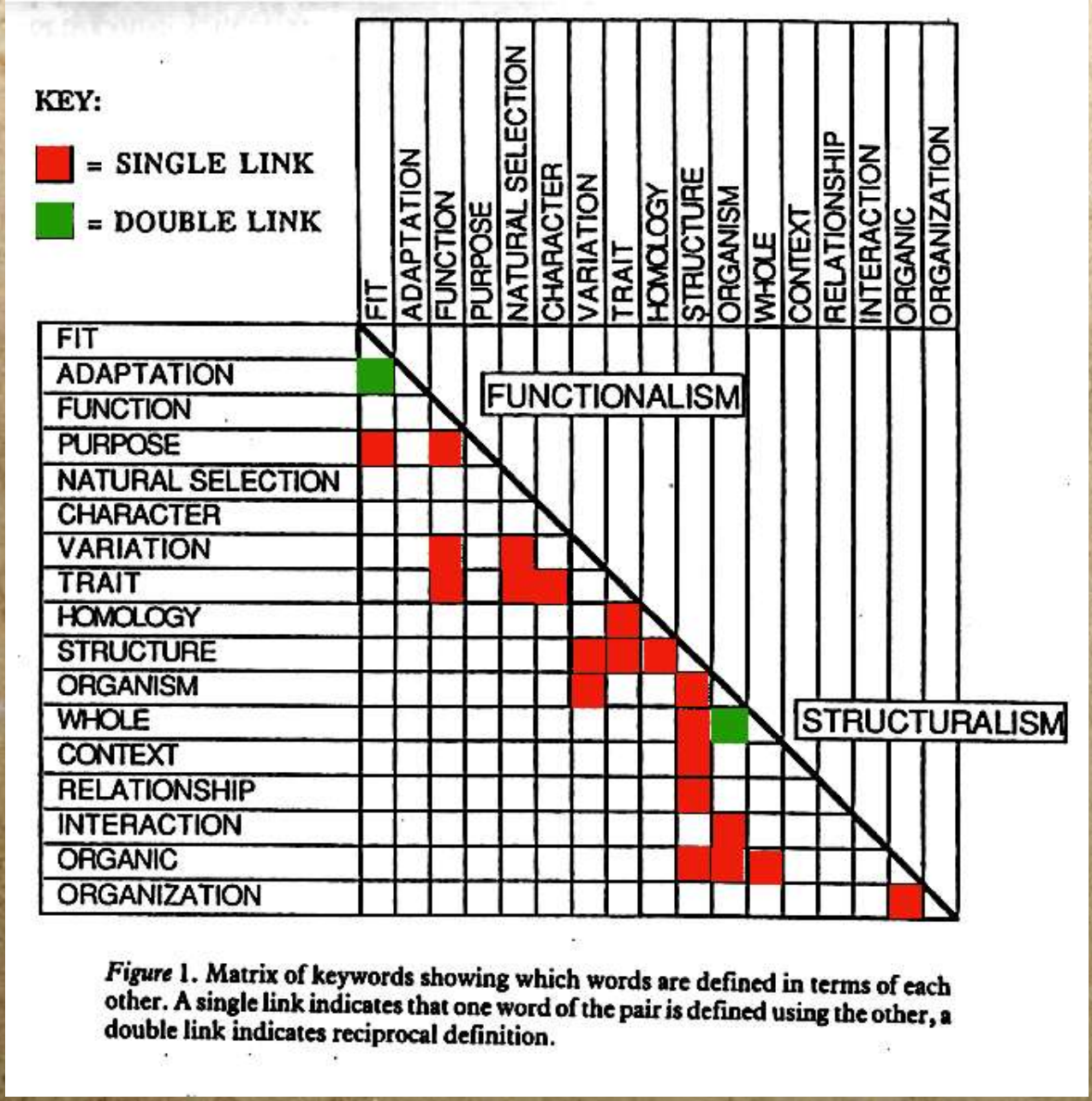

Figure 1. Matrix of keywords showing which words are defined in terms of each other. A single link indicates that one word of the pair is defined using the other, a double link indicates reciprocal definition.

- Lambert and Hughes. (1989), Keywords and concepts in Structuralist and Functionalist Biology

Use of teleology in popular journal article titles

- Common themes in the design and function of bacterial effectors
- Sperm design and sperm function
- Design and function of superfast muscles: new insights into the physiology of skeletal muscle

So, if Mechanistic and Teleological explanations are so problematic for us, what do we do?

- Kant's proposal - We need to introduce a new causality into natural science
- A causality that encompasses and supervenes both mechanism and teleology
- Mechanism works up to a point, and teleology adds a certain amount of extra explanation, but fundamentally we could do with something new

A potential way to get out of the problem?

- Introducing the supersensible

Other ways of approaching the causality problem in organisms

- **Quantum theory** has allegedly acausal phenomena, are there any examples of similar occurrences in the larger world?

- **Extremal Principles** - such as the Hamilton-Jacobi theory subsume mechanism, and the purposive notion of teleology to a principle that encompasses both, (Feynman, 1967; Hirschmann, 1988; Bohm, 1992)

Bio-solitons as an introduction to acausal phenomena in organisms

- Have the property at the visible, macromolecular level of behaving like elementary particles such as protons and other fermions, (Kruskal and Zabusky, 1962)
- also referred to as ‘wave-atoms’, (Petoukhov, 2002)
- Described by extremal principles

Occurences of Bio-solitons

- DNA replication forks (Yakushevich, 2002)
- Self organisation of the cytoskeleton during cell division (Petoukhov, 1999)
- Energy transfer in microtubules as a type of kink wave, (Elcio *et al*, 2001)
- Symmetry breaking in morphogenesis of the organism, (Mainzer, 2005)
- Muscle contraction systems, (Davydov, 1982)
- Activation waves proceeding somite formation, (Goodwin, *pers comm*)

Summary

- A - Mechanistic and teleological explanations seem to run into major problems with respect to organisms
- B - Extremal principles are an apparently acausal method of explanation.
- C - Solitons are examples of phenomena that are best described by extremal principles, and so can be described acausally.
- D - Solitons also behave at the visible level like elementary particles (such as protons and other fermions), i.e. like wave - particles.
- E - Organisms are full of types of solitons. These solitons are involved in a wide range of processes such as cell division, morphogenesis, activation waves in somite formation, DNA transcription, protein backbones, nerve impulses and also in muscle contraction, blood flow and locomotion.

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