

Teleology and Function

"Haldane [in the '30s] can be found remarking, 'Teleology is like a mistress to a biologist: he cannot live without her but he's unwilling to be seen with her in public.' Today the mistress has become a lawfully wedded wife. Biologists no longer feel obligated to apologize for their use of teleological language; they flaunt it. The only concession which they make to its disreputable past is to rename it 'teleonomy' ." David Hull (1982)

Aristotle: For the sake of what?



- "Democritus, however, neglecting the final cause, reduces to necessity all the operations of nature. Now they are necessary, it is true, but yet they are *for* a final cause and *for the sake of* what is best in each case. Thus nothing prevents the teeth from being formed and being shed in this way; but it is not on account of these causes but on account of the end; these are causes in the sense of being the moving and efficient instruments and the material. ...to say that necessity is the cause is much as if we should think that the water has been drawn off from a dropsical patient on account of the lancet alone, not on account of health, for the sake of which the lancet made the incision." Aristotle, *Generation of Animals* V.8, 789a8-b15

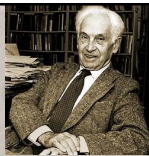
The Spookiness of Teleology

- For Aristotle, natural phenomena were teleological
 - Events happened **to** produce results
 - These results explain the events even though they come after the events
 - "Nature adapts the organ to the function, and not the function to the organ" (*De partib. animal.*, IV, xii, 694b; 13)
- Teleology seems to involve backwards causation—the effects (function) of some causal process are its cause
 - In the case of human planning, it is not the actual effect that causes the action, but the *thought* of the effect
 - But there is only prior thought for biology if one is a creationist

Teleology—Hard to Kill

- The scientific revolution seemed to remove purpose from the world
 - Events happened solely because of prior causes
 - Captured by the quest for mechanisms in biology
 - Mechanisms explained their effects in terms of preceding, efficient causes
- But teleological talk lives on in the language of functions in biology
 - The heart's function is to pump the blood
 - The kidney's function is to filter and remove waste
 - The function of the ribosome is to synthesize proteins
- Evident most clearly in the willingness to say that something is malfunctioning.

Ernst Mayr on Teleology



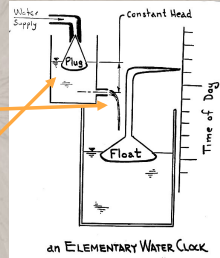
- “Consider the following statement: ‘The Wood Thrush migrates in the fall into warmer countries in order to escape the inclemency of the weather and the food shortages of the northern climates’. If we replace the words ‘in order to’ by ‘and thereby’, we leave the important question unanswered as to why the Wood Thrush migrates. The teleonomic form of the statement implies that *the goal-directed migratory activity is governed by a program*. By omitting this important message the translated sentence is greatly impoverished as far as information content is concerned, without gaining in causal strength.” Mayr (1974)

Naturalizing Teleology

- Ground (reduce) teleological notions in natural phenomena
- Show under what conditions a natural system has purposes or goals
- Two main naturalizing strategies:
 1. Negative Feedback and Cybernetics
 - More recently—language of a program directing activity
 2. Products of Natural Selection

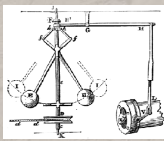
Negative Feedback

- First known example of negative feedback: Water clock designed by Ktesibios in the 3rd century BCE
 - Need to maintain constant water pressure
 - Employed a float that would start or halt the inflow from the water supply, maintaining a constant level



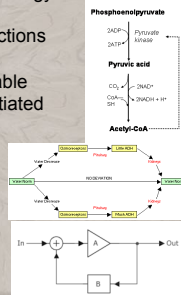
Industrialization and Negative Feedback

- James Watt faced a serious practical challenge
 - How to control the speed of the steam engine so that all appliances would run at the same rate despite different number being on line at a time
 - Devised an elegant mechanism for feedback control



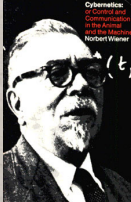

Negative Feedback in Biology

- Negative feedback is widespread in biology
 - Biochemical systems: products of reactions feed back to slow reactions earlier in the pathway
 - Physiological systems: when variable deviates from norm, processes initiated to restore it to normal
 - Motor systems: when action misses the mark, change to guide it to the target
- Walter Cannon: homeostasis




Recognizing the Generality of Negative Feedback

- Challenge: how to control gun fire targeting aircraft
 - Use feedback from the first shot to correct the next
 - Later, heat seeking missiles and beyond
- Recognizing the commonality between control of anti-aircraft fire and control in biological system, Norbert Wiener created an interdisciplinary movement
 - Cybernetics—from the Greek for helmsperson



The Seeming Insufficiency of Negative Feedback

- Humanly designed negative feedback systems all involve a designer
 - Who so arranged the parts of the system so that it would reach the target?
- The designer imposed the goal on the system
 - But where is the designer of biological systems: how did the organism become so organized that it could compensate for deviations?



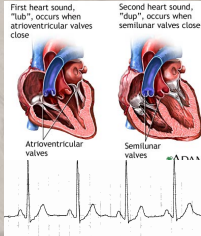
Teleology and Darwin

- Recall Darwin's high regard for Paley
 - Biological organisms are complex systems that are highly adaptive (functional) in their environments
- Darwin offered an (mechanistic) explanation for traits that had seemed to require design
 - Does natural selection remove the last vestige of teleology from science? *or*
 - Does natural selection license teleological discourse in biology
 - The function of a trait is that effect of it on which natural selection operated—that caused ancestors with the trait to reproduce more successfully

Wright's Distinction Between a Trait's Function and Other Effects

"Very likely the central distinction of this analysis is that between the *function* of something and other things it does which are *not* its function (or one of its functions). . . . The function of the heart is pumping blood, not producing a thumping noise or making wiggly lines on electrocardiograms, which are also things, it does. This is sometimes put as the distinction between a function, and something done merely 'by accident' ."

(Wright, p. 141)



Wright: Functions as Explanatory

- "Merely saying of something, X, that it has a certain function, is to offer an important kind of explanation of X."
 - The heart beats *in order to* circulate blood
 - To ask "what is the function of X?" is comparable to asking "Why do C' s have X' s (or do X)?"
- The sought for explanatory concerns how X came to be—it came to be because of its function
- But remember the challenge: the function is realized only after X
 - How could what comes later explain what came earlier?

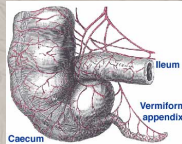
Natural Selection as an Explanation

- If an organ has been naturally differentially selected-for by virtue of something it does, we can say that the reason the organ is there is that it did/does that something. Hence we can say
 - animals have kidneys *because* they eliminate metabolic wastes from the bloodstream;
 - porcupines have quills *because* they protect them from predatory enemies;
 - plants have chlorophyll *because* chlorophyll enables plants to accomplish photosynthesis;
 - the heart beats *because* its beating pumps blood.
- The function of X is Z means
 - (a) X is there because it does (did) Z
 - (b) Z is a consequence (or result) of X's being there



Challenges for the Etiological Account

- Cave fish have remnants of an eye
 - What is its function?
 - It was originally selected for sight
 - Is that still its function?
- What is the function of the human appendix?
 - Darwin: used by other primates to digest leaves
 - Is that its function in us?



An Alternative to the Etiological Interpretation of Function

- Cummins further challenges the principle underlying etiological account, viz.:
 - “The point of functional characterization in science is to explain the presence of the item (organ, mechanism, process or whatever) that is functionally characterized”
 - Problem: most functional items are neither necessary nor sufficient for realizing the function and so their occurrence is not explained by citing the function



Relocating the Explanatory Role of Functions

- Cummins claims that it is more plausible that the statement
 - “The heartbeat in vertebrates has the function of circulating the blood through the organism.”is appealed to in *explaining circulation* (the function)
 - That is, we start with circulation, and identify something as having that function in the context of explaining it
 - And may explain the *advantage* of the heartbeat by identifying the activity it facilitates
 - This is different than explaining the existence of the heartbeat

Cummins' Account of Explaining How Something Performs a Function

- Functions and dispositions: "to attribute a function to something is, in part, to attribute a disposition to it. If the function of x in s to Φ , then x has a disposition to Φ in s "
- Dispositions require explanation:
 - "if x has [disposition] d , then x is subject to a regularity in behavior special to things having d , and such a fact needs to be explained."
- The appropriate explanatory strategy: Analytic strategy:
 - Analyze " d of a into a number of other dispositions d_1, \dots, d_n , had by a or components of a such that programmed manifestation of the d_i results in or amounts to a manifestation of d "

Analytic Strategy in Biology


- "The biologically significant capacities of an entire organism are explained by analyzing the organism into a number of 'systems'—the circulatory system, the digestive system, the nervous system, etc.—each of which has its characteristic capacities. These capacities are in turn analyzed into capacities of component organs and structures. Ideally, this strategy is pressed until pure physiology takes over, i.e., until the analyzing capacities are amenable to the subsumption strategy."
- This should seem familiar: mechanism in biology exemplifies this approach

But What Dispositions are Functions?

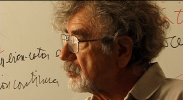
- Cummins offers a strategy for explaining functions by treating them as dispositions
 - But which dispositions are functions?
- Considers a condition such as "contributes to the proper working order" of the system of which it is a part
 - Considers whether these could be cast as "*health and life*" or "*contributing to the survival of the species*"
 - NO!
 - Picks out the wrong instances on some occasions
 - Doesn't explain why these are functions
- What's left is the style of explanation used for functions
 - BUT, the same strategy is invoked for pathologies
 - Does the gene for schizophrenia have the function of producing schizophrenia?

Construals of Function Talk

- The *etiological* strategy: explain the function of something in terms of what it was selected for
 - Treat it as an adaptation
 - Function explained etiologically
- The *functional analysis* strategy: explain how something is able to perform a function
 - Treat functions as dispositions of things
 - Decompose the disposition into sub-dispositions
- A third alternative: explain the function in terms of the contribution something makes to the operation of systems that maintain themselves far-from-equilibrium
 - Detach function from natural selection
 - Function in terms of contributions to the maintenance of life in a living system




Autopoiesis and Teleology



- Recall Bichat: Living organisms characterized by resistance to death
- Bernard tried to explain such a capacity mechanistically
 - Components of the system operate *so as to maintain* the constancy of the internal environment
- Given the degenerating effects of an environment, organisms must continually repair *themselves* or die
- Maturana and Varela
 - An autopoietic machine is a machine organized . . . as a network of processes of production . . . which: (i) through their interactions and transformations continuously regenerate and realize the network of processes . . . that produced them; and (ii) constitute it (the machine) as a concrete unity . . .
- The processes that maintain an autopoietic machine can be understood as teleological—serving its own maintenance

Biological Organisms as Autonomous Systems



- 2nd law of thermodynamics: In an open system entropy (disorder) always increases
- Maintaining the organization of a living organism requires using energy to resist the increase in entropy
- Moreno characterizes such systems as *autonomous*
 - “a far-from-equilibrium system that **constitutes and maintains itself** establishing an **organizational identity** of its own, a functionally integrated (homeostatic and active) unit based on a set of endergonic-exergonic couplings between internal self-constructing processes, as well as with other processes of interaction with its environment”
 - Kepa Ruiz-Mirazo, Juli Peretó and Alvaro Moreno, A Universal Definition Of Life: Autonomy And Open-ended Evolution
- These self-maintaining processes appear as teleological
