



## Functional Analysis

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## FUNCTIONAL ANALYSIS

A SURVEY of the recent philosophical literature on the nature of functional analysis and explanation, beginning with the classic essays of Hempel in 1959 and Nagel in 1961, reveals that philosophical research on this topic has almost without exception proceeded under the following assumptions: \*

- (A) The point of functional characterization in science is to explain the presence of the item (organ, mechanism, process or whatever) that is functionally characterized.
- (B) For something to perform its function is for it to have certain effects on a containing system, which effects contribute to the performance of some activity of, or the maintenance of some condition in, that containing system.

Putting these two assumptions together we have: a function-ascribing statement explains the presence of the functionally characterized item *i* in a system *s* by pointing out that *i* is present in *s* because it has certain effects on *s*. Give or take a nicety, this fusion of (A) and (B) constitutes the core of almost every recent attempt to give an account of functional analysis and explanation. Yet these assump-

\* Cf., Carl Hempel, "The Logic of Functional Analysis," in *Aspects of Scientific Explanation* (New York: Free Press, 1965), reprinted from Llewellyn Gross, ed., *Symposium on Sociological Theory* (New York: Harper & Row, 1959), and Ernest Nagel, *The Structure of Science* (New York: Harcourt Brace Jovanovich, 1961), ch. 12, sec. 1. The assumptions, of course, predate Hempel's 1959 essay. See, for instance, Richard Braithwaite, *Scientific Explanation* (Cambridge: University Press, 1955), ch. x, and Israel Scheffler, "Thoughts on Teleology," *British Journal for the Philosophy of Science*, ix, 36 (February 1959): 265-284. More recent examples include Francisco Ayala, "Teleological Explanations in Evolutionary Biology," *Philosophy of Science*, xxxvii, 1 (March 1970): 1-15; Hugh Lehman, "Functional Explanations in Biology," *ibid.*, xxxii, 1 (January 1965): 1-20; Richard Sorabji, "Function," *Philosophical Quarterly*, xiv, 57 (October 1964): 289-302; and Larry Wright, "Functions," *Philosophical Review*, lxxxii, 2 (April 1973): 139-168.

tions are just that: assumptions. They have never been systematically defended; generally they are not defended at all. I think there are reasons to suspect that adherence to (A) and (B) has crippled the most serious attempts to analyze functional statements and explanation, as I will argue in sections I and II below. In section III, I will briefly develop an alternative approach to the problem. This alternative is recommended largely by the fact that it emerges as the obvious approach once we take care to understand why accounts involving (A) and (B) go wrong.

## II

I begin this section with a critique of Hempel and Nagel. The objections are familiar for the most part, but it will be well to have them fresh in our minds, for they form the backdrop against which I stage my attack on (A) and (B).

Hempel's treatment of functional analysis and explanation is a classic example of the fusion of (A) and (B). He begins by considering the following singular function-ascribing statement:

- (1) The heartbeat in vertebrates has the function of circulating the blood through the organism.

He rejects the suggestion that 'function' can *simply* be replaced by 'effect' on the grounds that, although the heartbeat has the effect of producing heartsounds, this is not its function. Presuming (B) from the start, Hempel takes the problem to be how the effect the having of which is the function of the heartbeat (circulation) is to be distinguished from other effects of the heartbeat (e.g., heartsounds). His answer is that circulation, but not heartsounds, ensures a necessary condition for the "proper working of the organism." Thus, Hempel proposes (2) as an analysis of (1).

- (2) The heartbeat in vertebrates has the effect of circulating the blood, and this ensures the satisfaction of certain conditions (supply of nutriment and removal of waste) which are necessary for the proper working of the organism.

As Hempel sees the matter, the main problem with this analysis is that functional statements so construed appear to have no explanatory force. Since he assumes (A), the problem for Hempel is to see whether (2) can be construed as a deductive nomological explanans for the presence of the heartbeat in vertebrates, and, in general, to see whether statements having the form of (2) can be construed as deductive nomological explananda for the presence in a system of some trait or item that is functionally characterized.

Suppose, then, that we are interested in explaining the occurrence of a trait  $i$  in a system  $s$  (at a certain time  $t$ ), and that the following functional analysis is offered:

- (a) At  $t$ ,  $s$  functions adequately in a setting of kind  $c$  (characterized by specific internal and external conditions).
- (b)  $s$  functions adequately in a setting of kind  $c$  only if a certain necessary condition,  $n$ , is satisfied.
- (c) If trait  $i$  were present in  $s$  then, as an effect, condition  $n$  would be satisfied.
- (d) Hence, at  $t$ , trait  $i$  is present in  $s$  (Hempel, 310).

(d), of course, does not follow from (a)–(c), since some trait  $i'$  different from  $i$  might well suffice for the satisfaction of condition  $n$ . The argument can be patched up by changing (c) to (c'): "Condition  $n$  would be satisfied in  $s$  only if trait  $i$  were present in  $s$ ," but Hempel rightly rejects this avenue on the grounds that instances of the resulting schema would typically be false. It is false, for example, that the heart is a necessary condition for circulation in vertebrates, since artificial pumps can be, and are, used to maintain the flow of blood. We are thus left with a dilemma. If the original schema is correct, then functional explanation is invalid. If the schema is revised so as to ensure the validity of the explanation, the explanation will typically be unsound, having a false third premise.

Ernest Nagel offers a defense of what is substantially Hempel's schema with (c) replaced by (c').

. . . a teleological statement of the form, "The function of  $A$  in a system  $S$  with organization  $C$  is to enable  $S$  in the environment  $E$  to engage in process  $P$ ," can be formulated more explicitly by: every system  $S$  with organization  $C$  and in environment  $E$  engages in process  $P$ ; if  $S$  with organization  $C$  and in environment  $E$  does not have  $A$ , then  $S$  does not engage in  $P$ ; hence,  $S$  with organization  $C$  must have  $A$  (Nagel, 403).

Thus he suggests that (3) is to be rendered as (4):

- (3) The function of chlorophyll in plants is to enable them to perform photosynthesis.
- (4) A necessary condition for the occurrence of photosynthesis in plants is the presence of chlorophyll.

So Nagel must face the second horn of Hempel's dilemma: (3) is presumably true, but (4) may well be false. Nagel is, of course, aware of this objection. His rather curious response is that, as far as we know, chlorophyll is necessary for photosynthesis in the green plants (404). This may be so, but the response will not survive a change of example. Hearts are *not* necessary for circulation, artificial pumps

having actually been incorporated into the circulatory systems of vertebrates in such a way as to preserve circulation and life.

A more promising defense of Nagel might run as follows. Although it is true that the presence of a working heart is not a necessary condition of circulation in vertebrates under all circumstances, still, under *normal* circumstances—most circumstances in fact—a working heart is necessary for circulation. Thus it is perhaps true that, at the present stage of evolution, a vertebrate that has not been tampered with surgically would exhibit circulation only if it were to contain a heart. If these circumstances are specifically included in the explanans, perhaps we can avoid Hempel's dilemma. Thus, instead of (4) we should have:

- (4') At the present stage of evolution, a necessary condition for circulation in vertebrates that have not been surgically tampered with is the operation of a heart (properly incorporated into the circulatory system).

(4'), in conjunction with statements asserting that a given vertebrate exhibits circulation and has not been surgically tampered with and is at the present stage of evolution, will logically imply that that vertebrate has a heart. It seems, then, that the Hempelian objection could be overcome if it were possible, given a true function-ascribing statement like (1) or (3), to specify "normal circumstances" in such a way as to make it true that, in those circumstances, the presence of the item in question is a necessary condition for the performance of the function ascribed to it.

This defense has some plausibility as long as we stick to the usual examples drawn from biology. But if we widen our view a bit, even within biology, I think it can be shown that this defense of Nagel's position will not suffice. Consider the kidneys. The function of the kidneys is to eliminate wastes from the blood. In particular, the function of my left kidney is to eliminate waste from my blood. Yet the presence of my left kidney is not, in normal circumstances, a necessary condition for the removal of the relevant wastes. Only if something seriously abnormal should befall my right kidney would the operation of my left kidney become necessary, and this only on the assumption that I am not hooked up to a kidney machine.<sup>1</sup>

<sup>1</sup> It might be objected here that, although it is the function of the kidneys to eliminate waste, that is not the function of a particular kidney unless operation of that kidney is necessary for removal of wastes. But suppose scientists had initially been aware of the existence of the left kidney only. Then, on the account being considered, anything they had said about the function of that organ would have been false, since, on that account, *it has no function in organisms having two kidneys!*

A less obvious counterexample derives from the well-attested fact of hemispherical redundancy in the brain. No doubt it is in principle possible to specify conditions under which a particular duplicated mechanism would be necessary for normal functioning of the organism, but (a) in most cases we are not in a position actually to do this, though we are in a position to make well-confirmed statements about the functions of some of these mechanisms, and (b) these circumstances are by no means the normal circumstances. Indeed, given the fact that each individual nervous system develops somewhat differently owing to differing environmental factors, the circumstances in question might well be different for each individual, or for the same individual at different times.

Apparently Nagel was pursuing the wrong strategy in attempting to analyze functional ascriptions in terms of necessary conditions. Indeed, we are still faced with the dilemma noticed by Hempel: an analysis in terms of necessary conditions yields a valid but unsound explanatory schema; analysis in terms of sufficient conditions along the lines proposed by Hempel yields a schema with true premises, but validity is sacrificed.

Something has gone wrong, and it is not too difficult to locate the problem. An attempt to explain the presence of something by appeal to what it does—its function—is bound to leave unexplained why something else that does the same thing—a functional equivalent—isn't there instead. In itself, this is not a serious matter. But the accounts we have been considering assume that explanation is a species of deductive inference, and one cannot deduce hearts from circulation. This is what underlies the dilemma we have been considering. At best, one can deduce circulators from circulation. If we make this amendment, however, we are left with a functionally tainted analysis; 'the function of the heart is to circulate the blood' is rendered 'a blood circulator is a (necessary/sufficient) condition of circulation, and *the heart is a blood circulator*'. The expression in italics is surely as much in need of analysis as the analyzed expression. The problem, however, runs much deeper than the fact that the performance of a certain function does not determine how that function is performed. The problem is rather that to "explain" the presence of the heart in vertebrates by appeal to what the heart *does* is to "explain" its presence by appeal to factors that are causally irrelevant to its presence. Even if it were possible, as Nagel claimed, to *deduce* the presence of chlorophyll from the occurrence of photosynthesis, this would fail to *explain* the presence of chlorophyll in green plants in just the way deducing the presence and height of a building

from the existence and length of its shadow would fail to explain why the building is there and has the height it does. This is not because all explanation is causal explanation: it is not. But to explain in the presence of a naturally occurring structure or physical process—to explain why it is there, why such a thing exists in the place (system, context) it does—this does require specifying factors that causally determine the appearance of that structure or process.<sup>2</sup>

There is, of course, a sense in which the question, "Why is  $x$  there?" is answered by giving  $x$ 's function. Consider the following exchange.  $X$  asks  $Y$ , "Why is that thing there (pointing to the gnomon of a sundial)?"  $Y$  answers, "Because it casts a shadow on the dial beneath, thereby indicating the time of day." It is exchanges of this sort that most philosophers have had in mind when they speak of functional explanation. But it seems to me that, although such exchanges do represent genuine explanations, the use of functional language in this sort of explanation is quite distinct from its explanatory use in science. In section III below, I will sketch what I think is the central explanatory use of functional language in science. Meanwhile, if I am right, the evident propriety of exchanges like that imagined between  $X$  and  $Y$  has led to premature acceptance of (A), and hence to concentration on what is, from the point of view of scientific explanation, an irrelevant use of functional language. For it seems to me that the question, "why is  $x$  there?" can be answered by specifying  $x$ 's function only if  $x$  is or is part of an artifact.  $Y$ 's answer, I think, explains the presence of the gnomon because it rationalizes the action of the agent who put it there by supplying his *reason* for putting it there. In general, when we are dealing with the result of a deliberate action, we may explain the result by explaining the action, and we may explain a deliberate action by supplying the agent's reason for it. Thus, when we look at a sundial, we assume we *know* in a general way how the gnomon came to be there: someone deliberately put it there. But we may wish to know *why* it was put there. Specifying the gnomon's function allows us to formulate what we suppose to be the unknown agent's reason for putting it there: he believed it would cast a shadow such that . . . , and so on.

<sup>2</sup> Even in the case of a designed artifact, it is at most the designer's *belief* that  $x$  will perform  $f$  in  $s$  which is causally relevant to  $x$ 's presence in  $s$ , not  $x$ 's actually performing  $f$  in  $s$ . The nearest I can come to describing a situation in which  $x$  performing  $f$  in  $s$  is causally relevant to  $x$ 's presence in  $s$  is this: the designer of  $s$  notices a thing like  $x$  performing  $f$  in a system like  $s$ , and this leads to belief that  $x$  will perform  $f$  in  $s$ , and this in turn leads the designer to put  $x$  in  $s$ .

When we do this, we are elaborating on what we assume is the crucial **causal factor** in determining the gnomon's presence, namely a certain deliberate action.

**If this is on the right track, then the viability of the sort of explanation in question should depend on the assumption that the thing functionally characterized is there as the result of deliberate action.** If that assumption is evidently false, specifying the thing's function will not answer the question. Suppose it emerges that the sundial is not, as such, an artifact. When the ancient building was ruined, a large stone fragment fell on a kind of zodiac mosaic and embedded itself there. Since no sign of the room remains, *Y* has mistakenly supposed the thing was designed as a sundial. As it happens, the local people have been using the thing to tell time for centuries; so *Y* is right about the function of the thing *X* pointed to.<sup>8</sup> But it is simply false that the thing is there because it casts a shadow, for there is no agent who put it there "because it casts a shadow." **Again, the function of a bowl-like depression in a huge stone may be to hold holy water, but we cannot explain why it is there by appeal to its function if we know it was left there by pre-historic glacial activity.**

If this is right, then (A) will lead us to focus on a type of explanation which will not apply to natural systems: chlorophyll and hearts are not "there" as the result of any deliberate action, and **hence the essential presupposition of the explanatory move in question is missing.** Once this becomes clear, to continue to insist that there *must* be *some* sense in which specifying the function of chlorophyll explains its presence is an act of desperation born of thinking there is no other explanatory use of functional characterization in science.

Why have philosophers identified functional explanation exclusively with the appeal to something's function in explaining why it is there? **One reason, I suspect, is a failure to distinguish teleological explanation from functional explanation, perhaps because functional concepts do loom large in "explanations" having a teleological form.** Someone who fails to make this distinction, but who senses that there is an important and legitimate use of func-

<sup>8</sup> *Is casting a shadow the function of this fragment? Standard use may confer a function on something: if I standardly use a certain stone to sharpen knives, then that is its function, or if I standardly use a certain block of wood as a door stop, then the function of that block is to hold my door open. If non-artifacts ever have functions, appeals to those functions cannot explain their presence. The things functionally characterized in science are typically not artifacts.*



tional characterization in scientific explanation, will see the problem as one of finding a legitimate explanatory role for functional characterization within the teleological form. Once we leave artifacts and go to natural systems, however, this approach is doomed to failure, as critics of teleology have seen for some time.

This mistake probably would have sorted itself out in time were it not that we do reason from the performance of a function to the presence of certain specific processes and structures, e.g., from photosynthesis to chlorophyll, or from coordinated activity to nerve tissue. This is perfectly legitimate reasoning: it is a species of inference to the best explanation. Our best (only) explanation of photosynthesis requires chlorophyll, and our best explanation of coordinated activity requires nerve tissue. But once we see what makes this reasoning legitimate, we see immediately that inference to an explanation has been mistaken for an explanation itself. Once this becomes clear, it becomes equally clear that (A) has matters reversed: given that photosynthesis is occurring in a particular plant, we may legitimately infer that chlorophyll is present in that plant precisely because chlorophyll enters into our best (only) explanation of photosynthesis, and given coordinated activity on the part of some animal, we may legitimately infer that nerve tissue is present precisely because nerve tissue enters into our best explanation of coordinated activity in animals.

To attempt to explain the heart's presence in vertebrates by appealing to its function in vertebrates is to attempt to explain the occurrence of hearts in vertebrates by appealing to factors that are causally irrelevant to its presence in vertebrates. This fact has given "functional explanation" a bad name. But it is (A) that deserves the blame. Once we see (A) as an undefended philosophical hypothesis about how to construe functional explanations rather than as a statement of the philosophical problem, the correct alternative is obvious: what we can and do explain by appeal to what something does is the behavior of a containing system.<sup>4</sup>

A much more promising suggestion in the light of these considerations is that (1) is appealed to in explaining *circulation*. If we reject (A) and adopt this suggestion, a simple deductive-nomological explanation with circulation as the explicandum turns out to be a sound argument.

<sup>4</sup> A confused perception of this fact no doubt underlies (B), but the fact that (B) is nearly inseparable from (A) in the literature shows how confused this perception is.

- (5) a. Vertebrates incorporating a beating heart in the usual way (in the way *s* does) exhibit circulation.  
 b. Vertebrate *s* incorporates a beating heart in the usual way.  
 c. Hence, *s* exhibits circulation.

Though by no means flawless, (5) has several virtues, not the least of which is that it does not have biologists passing by an obvious application of evolution or genetics, in favor of an invalid or unsound "functional" explanation of the presence of hearts. Also, the redundancy examples are easily handled; e.g., the removal of wastes is deduced in the kidney case.

The implausibility of (A) is obscured in examples taken from biology by the fact that there are two distinct uses of function statements in biology. Consider the following statements.

- (a) The function of the contractile vacuole in protozoans is elimination of excess water from the organism.  
 (b) The function of the neurofibrils in the ciliates is coordination of the activity of the cilia.

These statements can be understood in either of two ways. (i) They are generally used in explaining how the organism in question comes to exhibit certain characteristics or behavior. Thus (a) explains how excess water, accumulated in the organism by osmosis, is eliminated from the organism; (b) explains how it happens that the activity of the cilia in paramecium, for instance, is coordinated. (ii) They may be used in explaining the continued survival of certain organisms incorporating structures of the sort in question by indicating the survival value that would accrue to such organisms in virtue of having structures of that sort. Thus (a) allows us to infer that incorporation of a contractile vacuole makes it possible for the organism to be surrounded by a semi-permeable membrane, allowing the passage of oxygen into, and the passage of wastes out of, the organism. Relatively free osmosis of this sort is obviously advantageous, and this is made possible by a structure which solves the excess water problem. Similarly, ciliates incorporating neurofibrils will be capable of fairly efficient locomotion, the survival value of which is obvious.<sup>6</sup>

<sup>6</sup> Notice that the second use is parasitic on the first. It is only because the neurofibrils explain the coordinated activity of the cilia that we can assign a survival value to neurofibrils: the survival value of a structure *s* hangs on what capacities of the organism, if any, are explicable by appeal to the functioning of *s*.

The second sort of use occurs as part of an account which, if we are not careful, can easily be mistaken for an explanation of the presence of the sort of item functionally characterized, and this has perhaps encouraged philosophers to accept (A). For it might seem that natural selection provides the missing causal link between what something does in a certain type of organism and its presence in that type of organism. By performing their respective functions, the contractile vacuole and the neurofibrils help species incorporating them to survive, and thereby contribute to their own continued presence in organisms of those species, and this might seem to explain the presence of those structures in the organisms incorporating them.

Plausible as this sounds, it involves a subtle yet fundamental misunderstanding of evolutionary theory. A clue to the mistake is found in the fact that the contractile vacuole occurs in marine protozoans that have no excess-water problem but the reverse problem. Thus the function and effect on survival of this structure is not the same in all protozoans. Yet the explanation of its presence in marine and fresh-water species is almost certainly the same. This fact reminds us that the processes actually responsible for the occurrence of contractile vacuoles in protozoans are totally insensitive to what that structure does. Failure to appreciate this point not only lends spurious plausibility to (A) as applied to biological examples; it seriously distorts our understanding of evolutionary theory. Whether an organism  $o$  incorporates  $s$  depends on whether  $s$  is "specified" by the genetic "plan" which  $o$  inherits and which, at a certain level of abstraction, is characteristic of  $o$ 's species. Alterations in the plan are due to mutation. If a plan is altered so that it specifies  $s'$  rather than  $s$ , then the organisms inheriting this plan will incorporate  $s'$ , regardless of the function or survival value of  $s'$  in those organisms. If the alteration is advantageous, the number of organisms inheriting that plan may increase, and, if it is disadvantageous, their number may decrease. But this has no effect whatever on the plan, and therefore no effect whatever on the occurrence of  $s'$  in the organisms in question.

One sometimes hears it said that natural selection is an instance of negative feedback. If this is meant to imply that the relative success or failure of organisms of a certain type can affect their inherited characteristics, it is simply a mistake: the characteristics of organisms which determine their relative success are determined by their genetic plan, and the characteristics of these plans are utterly independent of the relative success of organisms having

them. Of course, if  $s$  is very disadvantageous to organisms having a plan specifying  $s$ , then organisms having such plans may disappear altogether, and  $s$  will no longer occur. We could, therefore, think of natural selection as reacting on the *set* of plans generated by mutation by weeding out the bad plans: natural selection cannot alter a plan, but it can trim the set. Thus, we may be able to explain why a given plan is not a failure by appeal to the functions of the structures it specifies. Perhaps this is what some writers have had in mind. But this is not to explain why, e.g., contractile vacuoles occur in certain protozoans, it is to explain why the sort of protozoan incorporating contractile vacuoles occurs. Since we cannot appeal to the relative success or failure of these organisms to explain why their genetic plan specifies contractile vacuoles, we cannot appeal to the relative success or failure of these organisms to explain why they incorporate contractile vacuoles.

Once we are clear about the explanatory role of functions in evolutionary theory, it emerges that **the function of an organ or process (or whatever) is appealed to to explain the biological capacities of the organism containing it, and from these capacities conclusions are drawn concerning the chances of survival for organisms of that type.** For instance, appeal to the function of the contractile vacuole in certain protozoans explains how these organisms are able to keep from exploding in fresh water. **Thus evolutionary biology does not provide support for (A) but for the idea instanced in (5): identifying the function of something helps to explain the capacities of a containing system.**<sup>6</sup>

(A) misconstrues functional explanation by misidentifying what is explained. Let us abandon (A), then, in favor of the view that functions are appealed to in explaining the capacities of containing systems, and turn our attention to (B).

Whereas (A) is a thesis about functional explanation, (B) is a thesis about the analysis of function-ascribing statements. Perhaps when divorced from (A), as it is in (5), it will fare better than it does in the accounts of Hempel and Nagel.

<sup>6</sup>In addition to the misunderstanding about evolutionary theory just discussed, biological examples have probably suggested (A) because biology was the *locus classicus* of teleological explanation. This has perhaps encouraged a confusion between the teleological *form* of explanation, incorporated in (A), with the explanatory role of functional ascriptions. Function-ascribing statements do occur in explanations having a teleological form, and, when they do, their interest is vitiated by the incoherence of that form of explanation. It is the legitimate use of function-ascribing statements that needs examination, i.e., their contribution to nonteleological theories such as the theory of evolution.

## II

In spite of the evident virtues of (5), (5a) has serious shortcomings as an analysis of (1). In fact it is subject to the same objection Hempel brings to the analysis that simply replaces 'function' by 'effect': vertebrates incorporating a working heart in the usual way exhibit the production of heartsounds, yet the production of heartsounds is not a function of hearts in vertebrates. The problem is that, whereas the production of certain effects is essential to the heart's performing its function, there are some effects production of which is irrelevant to the functioning of the heart. This problem is bound to infect any "selected-effects" theory, i.e., any theory built on (B).

What is needed to establish a selected-effects theory is a general formula that identifies the appropriate effects.<sup>7</sup> Both Hempel and Nagel attempt to solve this problem by identifying the function of something with just those effects which contribute to the maintenance of some special condition of, or the performance of some special activity of, some containing system. If this sort of solution is to be viable, there must be some principled way of selecting the relevant activities or conditions of containing systems. For no matter which effects of something you happen to name, there will be some activity of the containing system to which just those effects contribute, or some condition of the containing system which is maintained with the help of just those effects. Heart activity, for example, keeps the circulatory system from being entirely quiet, and the appendix keeps people vulnerable to appendicitis.<sup>8</sup>

Hempel suggests that, in general, the crucial feature of a containing system, contribution to which is to count as the functioning of a

<sup>7</sup> Larry Wright (*op. cit.*) is aware of this problem, but does not, to my mind, make much progress with it. Wright's analysis rules out "The function of the heart is to produce heart sounds," on the ground that the heart is not there because it produces heartsounds. I agree. But neither is it there because it pumps blood. Or if, as Wright maintains, there is a sense of 'because' in which the heart is there because it pumps blood and not because it produces heartsounds, then this sense of 'because' is as much in need of analysis as 'function'. Wright does not attempt to provide such an analysis, but depends on the fact that, in many cases, we are able to use the word in the required way. But we are also able to use 'function' correctly in a variety of cases. Indeed, if Wright is right, the words are simply interchangeable with a little grammatical maneuvering. The problem is to make the conditions of correct use explicit. Failure to do this means that Wright's analysis provides no insight into the problem of how functional theories are confirmed, or whence they derive their explanatory force.

<sup>8</sup> Surprisingly, when Nagel comes to formulate his general schema of functional attribution he simply ignores this problem, and thus leaves himself open to the trivialization just suggested. Cf., Nagel, *op. cit.*, p. 403.

contained part, is that the system be maintained in “adequate, or effective, or proper working order” (306). Hempel explicitly declines to discuss what constitutes “proper working order,” presumably because he rightly thinks that there are more serious problems with the analysis he is discussing than those introduced by this phrase. But it seems clear that for something to be in working order is just for it to be capable of performing its functions, and for it to be in adequate or effective or proper working order is just for it to be capable of performing its functions adequately or effectively or properly. Hempel seems to realize this himself, for in setting forth a deductive schema for functional explanation, he glosses the phrase in question as ‘functions adequately’ (310). More generally, if we identify the function of something  $x$  with those effects of  $x$  which contribute to the performance of some activity  $a$  or to the maintenance of some condition  $c$  of a containing system  $s$ , then we must be prepared to say as well that a function of  $s$  is to perform  $a$  or to maintain  $c$ . This suggests the following formulation of “selected-effects” theories.

- (6) The function of an  $F$  in a  $G$  is  $f$  just in case (the capacity for)  $f$  is an effect of an  $F$  incorporated in a  $G$  in the usual way (or: in the way *this*  $F$  is incorporated in *this*  $G$ ), and that effect contributes to the performance of a function of the containing  $G$ .

It seems that any theory based on (B)—what I have been calling “selected-effects” theories—must ultimately amount to something like (6).<sup>9</sup> Yet (6) cannot be the whole story about functional ascriptions.

Suppose we follow (6) in rendering, “The function of the contractile vacuole in protozoans is elimination of excess water from the organism.” The result is (7):

- (7) Elimination of excess water from the organism is an effect of a contractile vacuole incorporated in the usual way in a protozoan, and that effect contributes to the performance of a function of a protozoan.

In order to test (7) we should have to know a statement of the form, “ $f$  is a function of a protozoan.” Perhaps protozoans have no functions. If not, (7) is just a mistake. If they do, then presumably we shall have to appeal to (6) for an analysis of the statement attributing such a function, and this will leave us with another unanalyzed functional ascription. Either we are launched on a regress, or the

<sup>9</sup> Hugh Lehman (*op. cit.*) given an analysis that appears to be essentially like (6).

analysis breaks down at some level for lack of functions, or perhaps for lack of a plausible candidate for containing systems. If we do not wish simply to acquiesce in the autonomy of functional ascriptions, it must be possible to analyze at least some functional ascriptions without appealing to functions of containing systems. If (6) can be shown to be the only plausible formulation of theories based on (B), then no such theory can be the whole story.

Our question, then, is whether a thing's function can plausibly be identified with those of its effects contributing to production of some activity of, or maintenance of some condition of, a containing system, where performance of the activity in question is not a function of the containing system. Let us begin by considering Hempel's suggestion that functions are to be identified with production of effects contributing to proper working order of a containing system. I claimed earlier on that to say something is in proper working order is just to say that it properly performs its functions. This is fairly obvious in cases of artifacts or tools. To make a decision about which sort of behavior counts as working amounts to deciding about the thing's function. To say something is working, though not behaving or disposed to behave in a way having anything to do with its function, is to be open, at the very least, to the change of arbitrariness.

When we are dealing with a living organism, or a society of living organisms, the situation is less clear. If we say, "The function of the contractile vacuole in protozoans is elimination of excess water from the organism," we do make reference to a containing organism, but not, apparently, to its function (if any). However, since contractile vacuoles do a number of things having nothing to do with their function, there must be some implicit principle of selection at work. Hempel's suggestion is that, in this context, to be in "proper working order" is simply to be alive and healthy. This works reasonably well for certain standard examples, e.g., (1) and (3): circulation does contribute to health and survival in vertebrates, and photosynthesis does contribute to health and survival in green plants.<sup>10</sup> But, once again, the principle will not stand a change of example, even within the life sciences. First, there are cases in which proper functioning is actually inimical to health and life:

<sup>10</sup> Even these applications have their problems. Frankfurt and Poole ["Functional Explanations in Biology," *British Journal for the Philosophy of Science*, xvii (1966)] point out that heartsounds contribute to health and survival via their usefulness in diagnosis.



functioning of the sex organs results in the death of individuals of many species (e.g., certain salmon). Second, a certain process in an organism may have effects which contribute to health and survival but which are not to be confused with the function of that process: secretion of adrenalin speeds metabolism and thereby contributes to elimination of harmful fat deposits in overweight humans, but this is not a function of adrenalin secretion in overweight humans.

A more plausible suggestion along these lines in the special context of evolutionary biology is this:

- (8) The functions of a part or process in an organism are to be identified with those of its effects contributing to activities or conditions of the organism which sustain or increase the organism's capacity to contribute to survival of the species.

Give or take a nicety, (8) doubtless does capture a great many uses of functional language in biology. For instance, it correctly picks out elimination of excess water as the function of the contractile vacuole in fresh-water protozoans only, and correctly identifies the function of sex organs in species in which the exercise of these organs results in the death of the individual.<sup>11</sup>

In spite of these virtues, however, (8) is seriously misleading and extremely limited in applicability even within biology. Evidently, what contributes to an organism's capacity to maintain its species in one sort of environment may undermine that capacity in another. When this happens, we might say that the organ (or whatever) has lost its function. This is probably what we would say about the contractile vacuole if fresh-water protozoans were successfully introduced into salt water, for in this case the capacity explained would no longer be exercised. But if the capacity explained by appeal to the function of a certain structure continued to be exercised in the new environment, though now to the individual's detriment, we would not say that that structure had lost its function. If, for some reason, flying ceased to contribute to the capacity of pigeons to maintain their species, or even undermined that capacity to some extent,<sup>12</sup> we would still say that a function of the wings in pigeons is to enable them to fly. Only if the wings ceased to

<sup>11</sup> Michael Ruse has argued for a formulation like (8). See "Function Statements in Biology," *Philosophy of Science*, xxxviii, 1 (March 1971): 87-95, and *The Philosophy of Biology* (London: Hutchinson, 1973).

<sup>12</sup> Perhaps, in the absence of serious predators, with a readily available food supply, and with no need to migrate, flying simply wastes energy.



function as wings, as in the penguins or ostriches, would we cease to functionally analyze skeletal structure and the like with an eye to explaining flight. Flight is a capacity that cries out for explanation in terms of anatomical functions regardless of its contribution to the capacity to maintain the species.

What this example shows is that functional analysis can properly be carried on in biology quite independently of evolutionary considerations: a complex capacity of an organism (or one of its parts or systems) may be explained by appeal to a functional analysis regardless of how it relates to the organism's capacity to maintain the species. At best, then, (8) picks out those effects which will be called functions when what is in the offing is an application of evolutionary theory. As we shall see in the next section, (8) is misleading as well in that it is not *which* effects are explained but the style of explanation that makes it appropriate to speak of functions. (8) simply identifies effects which, as it happens, are typically explained in that style.

We have not quite exhausted the lessons to be learned from (8). The plausibility of (8) rests on the plausibility of the claim that, for certain purposes, we may assume that a function of an organism is to contribute to the survival of its species. What (8) does, in effect, is identify a function of an important class of (uncontained) containing systems without providing an analysis of the claim that a function of an organism is to contribute to the survival of its species.

Of course, an advocate of (8) might insist that it is no part of his theory to claim that maintenance of the species is a function of an organism. But then the defense of (8) would have to be simply that it describes actual usage, i.e., that it is in fact effects contributing to an organism's capacity to maintain its species which evolutionary biologists single out as functions. Construed in this way, (8) would, at most, tell us *which* effects are picked out as functions; it would provide no hint as to *why* these effects are picked out as functions. We know why evolutionary biologists are interested in effects contributing to an organism's capacity to maintain its species, but why call them functions? This is precisely the sort of question that a philosophical account of function-ascribing statements should answer. Either (8) is defended as an instance of (6)—maintenance of the species is declared a function of organisms—or it is defended as descriptive of usage. In neither case is any philosophical analysis provided. For in the first case (8) relies on an unanalyzed (and undefended) function-ascribing statement, and in the second it

fails to give any hint as to the point of identifying certain effects as functions.

The failings of (8) are, I think, bound to cripple any theory that identifies a thing's functions with effects contributing to some antecedently specified type of condition or behavior of a containing system. If the theory is an instance of (6), it launches a regress or terminates in an unanalyzed functional ascription; if it is not an instance of (6), then it is bound to leave open the very question at issue, viz., why are the selected effects seen as functions?

### III

In this section, I will sketch briefly an account of functional explanation which takes seriously the intuition that it is a genuinely distinctive style of explanation. The assumptions (A) and (B) form the core of approaches that seek to minimize the differences between functional explanations and explanations not formulated in functional terms. Such approaches have not given much attention to the characterization of the special explanatory strategy science employs in using functional language, for the problem as it was conceived in such approaches was to show that functional explanation is not really different in essentials from other kinds of scientific explanation. Once the problem is conceived in this way, one is almost certain to miss the distinctive features of functional explanation, and hence to miss the point of functional description. The account of this section reverses this tendency by placing primary emphasis on the kind of problem that is solved by appeal to functions.

1. *Functions and Dispositions.* Something may be capable of pumping even though it does not function as a pump (ever) and even though pumping is not its function. On the other hand, if something functions as a pump in a system  $s$  or if the function of something in a system  $s$  is to pump, then it must be capable of pumping in  $s$ .<sup>13</sup>

<sup>13</sup> Throughout this section I am discounting appeals to the intentions of designers or users.  $x$  may be intended to prevent accidents without actually being capable of doing so. With reference to this intention it *would* be proper in certain contexts to say, " $x$ 's function is to prevent accidents, though it is not actually capable of doing so."

There can be no doubt that a thing's function is often identified with what it is typically or "standardly" used to do, or with what it was designed to do. But the sorts of things for which it is an important scientific problem to provide functional analyses—brains, organisms, societies, social institutions—either do not have designers or standard or regular uses at all, or it would be inappropriate to appeal to these in constructing and defining a scientific theory because the designer or use is not known—brains, devices dug up by archaeolo-

Thus, function-ascribing statements imply disposition statements; to attribute a function to something is, in part, to attribute a disposition to it. If the function of  $x$  in  $s$  to  $\phi$ , then  $x$  has a disposition to  $\phi$  in  $s$ . For instance, if the function of the contractile vacuole in fresh-water protozoans is to eliminate excess water from the organism, then there must be circumstances under which the contractile vacuole would actually manifest a disposition to eliminate excess water from the protozoan that incorporates it.

To attribute a disposition  $d$  to an object  $a$  is to assert that the behavior of  $a$  is subject to (exhibits or would exhibit) a certain lawlike regularity: to say  $a$  has  $d$  is to say that  $a$  would manifest  $d$  (shatter, dissolve) were any of a certain range of events to occur ( $a$  is put in water,  $a$  is struck sharply). The regularity associated with a disposition—call it the *dispositional regularity*—is a regularity that is special to the behavior of a certain kind of object and obtains in virtue of some special fact(s) about that kind of object. Not everything is water-soluble: such things behave in a special way in virtue of certain (structural) features special to water-soluble things. Thus it is that dispositions require explanation: if  $x$  has  $d$ , then  $x$  is subject to a regularity in behavior special to things having  $d$ , and such a fact needs to be explained.

To explain a dispositional regularity is to explain how manifestations of the disposition are brought about given the requisite precipitating conditions. In what follows, I will describe two distinct strategies for accomplishing this. It is my contention that the appropriateness of function-ascribing statements corresponds to the appropriateness of the second of these two strategies. This, I think, explains the intuition that functional explanation is a special kind of explanation.

## 2. Two Explanatory Strategies

(i) **The Subsumption Strategy.** Suppose  $a$  has a disposition  $d$ . The associated dispositional regularity consists in the fact that certain kinds of events would cause  $a$  to manifest  $d$ . One way to explain this fact would be to discover some feature of  $a$  which allowed us to represent the connection between precipitating events and mani-

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gists—or because there is some likelihood that real and intended function diverge—social institutions, complex computers. Functional talk may have originated in contexts in which reference to intentions and purposes loomed large, but reference to intentions and purposes does not figure at all in the sort of functional analysis favored by contemporary natural scientists.

festations as instances of one or more *general* laws, i.e., laws governing the behavior of things generally, not just things having *d*. Brian O'Shaughnessy has provided an example which allows a particularly simple illustration of this strategy.<sup>14</sup> Consider the disposition he calls *elevancy*: the tendency of an object to rise in water of its own accord. To explain elevancy, we must explain why freeing a submerged elevant object causes it to rise.<sup>15</sup> This we may do as follows. In every case, the ratio of an elevant object's mass to its non-permeable volume is less than the density (mass per unit volume) of water. Archimedes' principle tells us that water exerts an upward force on a submerged object equal to the weight of the water displaced. In the case of an elevant object, this force evidently exceeds the weight of the object by some amount *f*. Freeing the object changes the net force on it from zero to a net force of magnitude *f* in the direction of the surface, and the object rises accordingly. Here, we subsume the connection between freeings and risings under a general law connecting changes in net force with changes in motion by citing a feature of elevant objects which allows us (via Archimedes' principle) to represent freeing them under water as an instance of introducing a net force in the direction of the surface.

(ii) **The Analytical Strategy.** Rather than subsume a dispositional regularity under a law not special to the disposed objects, the analytical strategy proceeds by analyzing a disposition *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*.<sup>16</sup> The two strategies will fit together into a unified account if the analyzing dispositions (the  $d_i$ ) can be made to yield to the subsumption strategy.

When the analytical strategy is in the offing, one is apt to speak of capacities (or abilities) rather than of dispositions. This shift in terminology will put a more familiar face on the analytical

<sup>14</sup> "The Powerlessness of Dispositions," *Analysis*, xxxi.1, 139 (October 1970): 1-15. See also my discussion of this example in "Dispositions, States and Causes," *ibid.*, xxxiv.6, 162 (June 1974): 194-204.

<sup>15</sup> Also, we must explain why submerging a free elevant object causes it to rise, and why a free submerged object's becoming elevant causes it to rise. One of the convenient features of elevancy is that the same considerations dispose of all these cases. This does not hold generally: gentle rubbing, a sharp blow, or a sudden change in temperature may each cause a glass to manifest a disposition to shatter, but the explanations in these cases are significantly different.

<sup>16</sup> By "programmed" I simply mean organized in a way that could be specified in a program or flow chart: each instruction (box) specifies manifestation of one of the  $d_i$  such that, if the program is executed (the chart followed), *a* manifests *d*.

strategy,<sup>17</sup> for we often explain capacities by analyzing them. Assembly-line production provides a transparent example of what I mean. Production is broken down into a number of distinct tasks. Each point on the line is responsible for a certain task, and it is the function of the workers/machines at that point to complete that task. If the line has the capacity to produce the product, it has it in virtue of the fact that the workers/machines have the capacities to perform their designated tasks, and in virtue of the fact that when these tasks are performed in a certain organized way—according to a certain program—the finished product results. Here we can explain the line's capacity to produce the product—i.e., explain how it is able to produce the product—by appeal to certain capacities of the workers/machines and their organization into an assembly line. Against this background, we may pick out a certain capacity of an individual exercise of which is his function on the line. Of the many things he does and can do, his function on the line is doing whatever it is that we appeal to in explaining the capacity of the line as a whole. If the line produces several products, i.e., if it has several capacities, then, although a certain capacity *c* of a worker is irrelevant to one capacity of the line, exercise of *c* by that worker may be his function with respect to another capacity of the line as a whole.

Schematic diagrams in electronics provide another obvious illustration. Since each symbol represents any physical object whatever having a certain capacity, a schematic diagram of a complex device constitutes an analysis of the electronic capacities of the device as a whole into the capacities of its components. Such an analysis allows us to explain how the device as a whole exercises the analyzed capacity, for it allows us to see exercises of the analyzed capacity as programmed exercise of the analyzing capacities. In this case, the "program" is given by the lines indicating how the components are hooked up. (Of course, the lines are themselves function symbols.)

Functional analysis in biology is essentially similar. The biologically significant capacities of an entire organism are explained

<sup>17</sup> Some might want to distinguish between dispositions and capacities, and argue that to ascribe a function to *x* is in part to ascribe a *capacity* to *x*, not a disposition as I have claimed. Certainly (1) is strained in a way (2) is not.

- (1) Hearts are disposed to pump.  
Hearts have a disposition to pump.  
Sugar is capable of dissolving.  
Sugar has a capacity to dissolve.
- (2) Hearts are capable of pumping.  
Hearts have a capacity to pump.  
Sugar is disposed to dissolve.  
Sugar has a disposition to dissolve.

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.<sup>18</sup> 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. We can easily imagine biologists expressing their analyses in a form analogous to the schematic diagrams of electrical engineering, with special symbols for pumps, pipes, filters, and so on. Indeed, analyses of even simple cognitive capacities are typically expressed in flow charts or programs, forms designed specifically to represent analyses of information processing capacities generally.

Perhaps the most extensive use of the analytical strategy in science occurs in psychology, for a large part of the psychologist's job is to explain how the complex behavioral capacities of organisms are acquired and how they are exercised. Both goals are greatly facilitated by analysis of the capacities in question, for then acquisition of the analyzed capacity resolves itself into acquisition of the analyzing capacities and the requisite organization, and the problem of performance resolves itself into the problem of how the analyzing capacities are exercised. This sort of strategy has dominated psychology over since Watson attempted to explain such complex capacities as the ability to run a maze by analyzing the performance into a series of conditioned responses, the stimulus for each response being the previous response or something encountered as the result of the previous response.<sup>19</sup> Acquisition of the complex capacity is resolved into a number of distinct cases of simple conditioning, i.e., the ability to learn the maze is resolved into the capacity for stimulus substitution, and the capacity to run the maze is resolved into abilities to respond in certain simple ways to certain simple stimuli. Watson's analysis proved to be of limited value, but the analytic strategy remains the dominant mode of explanation in behavioral psychology.<sup>20</sup>

<sup>18</sup> Indeed, what makes something part of, e.g., the nervous system is that its capacities figure in an analysis of the capacity to respond to external stimuli, coordinate movement, etc. Thus, there is no question that the glial cells are part of the brain, but there is some question as to whether they are part of the nervous system or merely auxiliary to it.

<sup>19</sup> John B. Watson, *Behaviorism* (New York: Norton, 1930) chs. ix and xi.

<sup>20</sup> Writers on the philosophy of psychology, especially Jerry Fodor, have grasped the connection between functional characterization and the analytical strategy in psychological theorizing, but have not applied the lesson to the problem of functional explanation generally. The clearest statement occurs in J. A. Fodor, "The Appeal to Tacit Knowledge in Psychological Explanation," this JOURNAL, LXV, 24 (December 19, 1968): 627-640.

3. *Functions and Functional Analysis.* In the context of an application of the analytical strategy, exercise of an analyzing capacity emerges as a function: it will be appropriate to say that  $x$  functions as a  $\phi$  in  $s$ , or that the function of  $x$  in  $s$  is  $\phi$ -ing, when we are speaking against the background of an analytical explanation of some capacity of  $s$  which appeals to the fact that  $x$  has a capacity to  $\phi$  in  $s$ . It is appropriate to say that the heart functions as a pump against the background of an analysis of the circulatory system's capacity to transport food, oxygen, wastes, and so on, which appeals to the fact that the heart is capable of pumping. Since this is the usual background, it goes without saying, and this accounts for the fact that "The heart functions as a pump" sounds right, and "The heart functions as a noise-maker" sounds wrong, in some context-free sense. This effect is strengthened by the absence of any actual application of the analytical strategy which makes use of the fact that the heart makes noise.<sup>21</sup>

We can capture this implicit dependence on an analytical context by entering an explicit relativization in our regimented reconstruction of function-ascribing statements:

- (9)  $x$  functions as a  $\phi$  in  $s$  (or: the function of  $x$  in  $s$  is to  $\phi$ ) relative to an analytical account  $A$  of  $s$ 's capacity to  $\psi$  just in case  $x$  is capable of  $\phi$ -ing in  $s$  and  $A$  appropriately and adequately accounts for  $s$ 's capacity to  $\psi$  by, in part, appealing to the capacity of  $x$  to  $\phi$  in  $s$ .

Sometimes we explain a capacity of  $s$  by analyzing it into other capacities of  $s$ , as when we explain how someone ignorant of cookery is able to bake cakes by pointing out that he followed a recipe each instruction of which requires no special capacities for its execution. Here, we don't speak of, e.g., stirring as a function of the cook, but rather of the function of stirring. Since stirring has different functions in different recipes and at different points in the same recipe, a statement like 'The function of stirring the mixture is to keep it from sticking to the bottom of the pot' is implicitly relativized to a certain (perhaps somewhat vague) recipe. To take account of this sort of case, we need a slightly different schema: where  $e$  is an activity or behavior of a system  $s$  (as a whole), the function of  $e$  in  $s$  is to  $\phi$  relative to an analytical account  $A$  of  $s$ 's capacity to  $\psi$  just in case  $A$  appropriately and adequately accounts for  $s$ 's capacity to  $\psi$  by, in part, appealing to  $s$ 's capacity to engage in  $e$ .

<sup>21</sup> It is sometimes suggested that heartsounds do have a psychological function. In the context of an analysis of a psychological disposition appealing to the heart's noise-making capacity, "The heart functions as a noise-maker" (e.g., as a producer of regular thumps), would not even *sound* odd.



(9) explains the intuition behind the regress-ridden (6): **functional ascriptions do require relativization to a “functional fact” about a containing system**, i.e., to the fact that a certain capacity of a containing system is approximately explained by appeal to a certain functional analysis. And, like (6), (9) makes no provision for speaking of the function of an organism except against a background analysis of a containing system (the hive, the corporation, the ecosystem). Once we see that functions are appealed to in explaining the capacities of containing systems, and indeed that it is the applicability of a certain strategy for explaining these capacities that makes talk of functions appropriate, we see immediately why we do not speak of the functions of uncontained containers. What (6) fails to capture is the fact that uncontained containers can be functionally analyzed, and the way in which function-analytical explanation mediates the connection between functional ascriptions ( $x$  functions as a  $\phi$ , the function of  $x$  is to  $\phi$ ) and the capacities of the containers.

4. *Function-analytical Explanation.* If the account I have been sketching is to draw any distinctions, the availability and appropriateness of analytical explanations must be a nontrivial matter.<sup>22</sup> So let us examine an obviously trivial application of the analytical strategy with an eye to determining whether it can be dismissed on principled grounds.

(10) **Each part of the mammalian circulatory system makes its own distinctive sound, and makes it continuously. These combine to form the “circulatory noise” characteristic of all mammals. The mammalian circulatory system is capable of producing this sound at various volumes and various tempos. The heartbeat is responsible for the throbbing character of the sound, and it is the capacity of the heart to beat at various rates that explains the capacity of the circulatory system to produce a variously tempoed sound.**

Everything in (10) is, presumably, true. The question is whether it allows us to say that the function of the heart is to produce a variously tempoed throbbing sound.<sup>23</sup> To answer this question we must, I think, get clear about the motivation for applying the analytical

<sup>22</sup> Of course, it might be that there are none but arbitrary distinctions to be drawn. Perhaps (9) describes usage, and usage is arbitrary, but I am unable to take this possibility seriously.

<sup>23</sup> The issue is not whether (10) forces us, via (9), to say something false. Relative to *some* analytical explanation, it may be true that the function of the heart is to produce a variously tempoed throbbing. But the availability of (10) should not support such a claim.



strategy. For my contention will be that the analytical strategy is most significantly applied in cases very unlike that envisaged in (10).

The explanatory interest of an analytical account is roughly proportional to (i) the extent to which the analyzing capacities are less sophisticated than the analyzed capacities, (ii) the extent to which the analyzing capacities are different in type from the analyzed capacities, and (iii) the relative sophistication of the program appealed to, i.e., the relative complexity of the organization of component parts/processes that is attributed to the system. (iii) is correlative with (i) and (ii): the greater the gap in sophistication and type between analyzing capacities and analyzed capacities, the more sophisticated the program must be to close the gap.

It is precisely the width of these gaps which, for instance, makes automata theory so interesting in its application to psychology. Automata theory supplies us with extremely powerful techniques for constructing diverse analyses of very sophisticated tasks into very unsophisticated tasks. This allows us to see how, in principle, a mechanism such as the brain, consisting of physiologically unsophisticated components (relatively speaking), can acquire very sophisticated capacities. It is the prospect of promoting the capacity to store ones and zeros into the capacity to solve logic problems and recognize patterns that makes the analytical strategy so appealing in cognitive psychology.

As the program absorbs more and more of the explanatory burden, the physical facts underlying the analyzing capacities become less and less special to the analyzed system. This is why it is plausible to suppose that the capacity of a person and of a machine to solve a certain problem might have substantially the same explanation, although it is not plausible to suppose that the capacities of a synthesizer and of a bell to make similar sounds have substantially similar explanations. There is no work to be done by a sophisticated hypothesis about the organization of various capacities in the case of the bell. Conversely, the less weight borne by the program, the less point to analysis. At this end of the scale we have cases like (10) in which the analyzed and analyzing capacities differ little if at all in type and sophistication. Here we could apply the subsumption strategy without significant loss, and thus talk of functions is comparatively strained and pointless. It must be admitted, however, that there is no black-white distinction here, but a case of more-or-less. As the role of organization becomes less and less significant, the analytical strategy becomes less and less appropriate, and talk of functions makes less and less sense. This may be philosophically disappointing, but there is no help for it.

## CONCLUSION

Almost without exception, philosophical accounts of function-ascribing statements and of functional explanation have been crippled by adoption of the assumptions (A) and (B). Though there has been wide-spread agreement that extant accounts are not satisfactory, (A) and (B) have escaped critical scrutiny, perhaps because they were thought of as somehow setting the problem rather than as part of proffered solutions. Once the problem is properly diagnosed, however, it becomes possible to give a more satisfactory and more illuminating account in terms of the explanatory strategy that provides the motivation and forms the context of function-ascribing statements, **To ascribe a function to something is to ascribe a capacity to it which is singled out by its role in an analysis of some capacity of a containing system.** When a capacity of a containing system is appropriately explained by analyzing it into a number of other capacities whose programmed exercise yields a manifestation of the analyzed capacity, the analyzing capacities emerge as functions. Since the appropriateness of this sort of explanatory strategy is a matter of degree, so is the appropriateness of function-ascribing statements.

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## BOOK REVIEWS

*The Anatomy of the Soul.* ANTHONY KENNY. Oxford: Basil Blackwell; New York: Barnes & Noble, 1973. ix, 147 p. \$8.50.

Not long before I was asked to review this book I ordered a copy of it from the catalogue of its British publishers, Blackwell, on the assumption that a new book of essays would not, unless clearly indicated in catalogue and advertisements, consist of unrevised reprints of already published material. But no: not only have all six of these essays appeared previously, but no fewer than four of them are on my shelves in other collections, three in cheap paperbacks. There must be very few teachers of philosophy, and even fewer college and university libraries, that do not already own most, if not all, of these materials. It is natural to ask, then, what special value this book can have for its intended readers and buyers.

Well, there is *some* new work here, in the form of an eighteen-page Appendix, consisting of an intended encyclopedia article on