Theo A. F. Kuipers

FUNCTIONAL SPECIFICATION AND FISH SWIMMING BACKWARD

REPLY TO ARNO WOUTERS

Arno Wouters presents a paradigmatic critical-constructive paper. First he explains in what sense my account of functional explanation has shortcomings. He then offers an account which he advocates as an improved account, that is, a refined and extended one. A very stimulating feature of all his work is his insistence on elaborating real-(scientific)-life examples, in this case backwards swimming fishes. I shall first respond to some of the things he has missed in my account (his Sections 2-5), before evaluating his account (Section 6) separately as well as comparatively, to use some of my favorite notions elaborated in the overlapping chapters of ICR and SiS.

Specifying Why Electric Fishes Swim Backward

Wouters’ general account of my approach in Section 2 is perfect. However, his treatment of the case study is somewhat problematic from my perspective. Before entering that, let me respond to some terminological points. In response to Note 2, I confirm that both Hempel and Nagel, with their distinct argumentative reconstructions of functional explanations, suggest that there is some “underlying argument” involved. In response to Note 4, I have to concede that the term ‘selection environment’ is technically indeed somewhat unfortunate, although in combination with ‘present environment’ no misunderstandings will arise. Perhaps a better combination of terms would be ‘environment of origin’ versus ‘environment of persistence’. Finally, the term ‘distal function’ (Note 5) is used in 4.2 and 6.2.1 of SiS, with ‘intermediate function’ as an alternative. The latter is certainly to be preferred.

In regard to the case study, I appreciate Wouters’ attempt at an “Explanation by Specification” (EbyS) analysis, culminating in the last paragraph of Section 4, but I am not satisfied with it, precisely because it does not deal adequately with what Wouters presents as missing points at the

beginning of Section 5. First, it is said to leave out “that the fish must swim backward to acquire [a] favorable position” because swimming has a function in scanning.” Second, according to Wouters, it “ignores the point that scanning is needed because of the physical characteristics of electrosensoric prey recognition” (which makes focusing impossible).

When reconstructing a case like this in terms of explanation by specification it is of the utmost importance to start, as far as possible, by disentangling the initial why-question, that is, why do the fish pass their potential prey backward? In my view the basic why-questions are: why do the fish pass their potential prey and why do they pass them backward? Let us start with the first question. Roughly speaking, it gets the EbyS answer: passing is a positive causal factor (henceforth, pcf) for scanning, which is a pcf for prey recognition, which is a pcf for survival. The first pcf-relation seems to be the core of Wouters’ first concern. However, when this relation has been established together with the second, this raises the further task of explaining it. More specifically, the question is how does scanning work such that the transitive conclusion – passing is a pcf for prey recognition – becomes true? Wouters’ paper teaches us that this has everything to do with the nature of electric fishes: passing many receptors is the only way in which such fishes can acquire a sufficiently high quality image. Hence, instead of ignoring the nature of scanning, Wouters’ second concern, its crucial how-question comes into focus. However, none of this as yet has anything to do with the primarily surprising phenomenon, backward swimming. We know that this should be interpreted as “backward passing,” for the passing is functional for scanning, but we still don’t know why it is “backward passing,” which is the second question. This gets the EbyS answer: passing backward (rather than forward) is a pcf for subsequent prey catching, which is a pcf for survival.

In sum, by splitting the original why-question into two different aspects of that behavior, we get two well-structured answers in terms of functional specification, one of which generates a crucial new how-question. The answers to the first question and to the how-question generated by it, directly pertain to the two points of attention Wouters is missing according to the above quotations. Combining these answers with the answer to the second why-question, the reconstruction “relate[s] the backward character of the swimming behavior of electric fishes to the fact that those fishes are electric fishes,” that is, the accomplishment that Wouters, at the end of Section 5, states is absent.
Wouters’ Improved Analysis

To be sure, Wouters in his own analysis introduces a number of sophistications. The main one is the distinction between, on the one hand, biological roles of items and activities and, on the other hand, biological advantages of specific properties or characters of them or of the organism as a whole. In terms of roles and advantages, the passing behavior in the example above plays a role in the scanning technique of electric fishes, whereas passing backward provides an advantage relative to passing forward. Surprisingly, he calls the ‘scanning-when-passing’ an advantage rather than (assigning it) a role. Be this as it may, Wouters calls the presence of a certain item or activity as well as their characters traits, but not the items and activities themselves, nor their having a certain character. In contrast to his suggestion in Note 6, I did not presuppose such, essentially linguistic, distinctions. At several places I just added ‘process/phenomenon’ between brackets after ‘trait’, to make sure I covered everything of which it makes sense to ask for a functional explanation, including processes like photosynthesis and phenomena like the stable clutch-size of plovers.

In the first paragraph of 6.2, Wouters submits at least two claims with his analysis relative to my account of what he calls “function attribution”:

I submit that the question addressed by a functional explanation typically has the form ‘why does item/activity $i$ of x-organisms has character $s_1$ rather than $s_2$?’, for example ‘why do electric fishes swim in both directions (rather than forwards only)?’. My point is not only that the question is comparative but also (and foremost) that the question is about the character of an item or activity, for example in the case of the electric fishes it is the backward character of the swimming behavior that is explained.

Regarding his second and foremost point, I hope I have shown above convincingly that a sensible explanation by specification of backward swimming is very possible. Hence, more generally, explanation by specification can perfectly deal with characters of items and activities, and their advantages, assuming that it can deal with their comparative nature, that is, Wouters’ first point. In my view, however, the latter is merely a matter of a (very important) concretization. As anticipated by Wouters, it is easy to make pcf-claims comparative, which I suggested already above with the phrase “passing backward (rather than forward).” The only thing one needs to do is to replace, and defend, probability statements of the form “$p(B/A) > p(B)$”, underlying pcf-claims, by statements of the form “$p(B/A) > p(B/C)$”, where $C$ is supposed to be incompatible with (the presence of) $A$. When $C$ just amounts to non-$A$, that is the absence of $A$, we get the weakest comparative case, which is in fact already included in the original condition, for “$p(B/A) > p(B/non-A)$”
is equivalent to \( p(B/A) > p(B) \), assuming non-zero probabilities. (See SiS, p.122, for some further suggestions.)

In the rest of his contribution Wouters gives a detailed reconstruction of the electric fish example, and a sketch of the fanning movement of male sticklebacks in front of their nest. Although both his reconstructions and the lessons attached to them are evidently more complex than my account would be, not all complexities are enriching concretizations. However, some complexities certainly are badly needed sophistications. For example, the exclusion of unintended illustrations of my “minimal account,” e.g. the Gibbon case. In such cases it becomes quite clear that, unlike me, Arno Wouters is not only a philosopher but also a biologist, and hence a plausible addressee of my simplified and idealized writing about functional explanation in biology. However, some other complexities are due to not splitting up questions. As suggested by my brief analysis of the electric fish case, and by ending my “train of thoughts” with the phrase “go to new, related why- and how-questions,” my basic strategy is the splitting up of questions, rather than trying to answer several questions in a complex story.

Strengthened by some later correspondence, I subscribe to Wouters’ claim that there are two important differences between our points of view. First, according to Wouters, a leading, if not the leading question of a functional analysis is that characters of items and activities have to be seen as advantageous solutions for problems or needs that are raised by the specific nature of them. Backward passing solves the problem that is created for electric fishes. Let me rephrase my analysis in this respect. The passing is functional: such fishes have to pass their prey in order to recognize it as such. Doing it in reverse is functional too: if they were to pass forwards they would end up in a poor catching position, hence, for such fishes it is advantageous to pass backwards. In general, a specific character of an activity is a solution to a problem that has arisen due to the specific nature of an item when that character is functional given that activity, and assuming that that activity is functional in view of the specific nature of the item. Hence, in my view, an EbyS analysis provides the building blocks for the answer to the type of question that interests Wouters. This brings me to the second main difference, and now I quote, with permission, from an e-mail from Wouters (June 26, 2002) in response to a draft of this reply:
For the rest, I find your remark that your basic strategy is the splitting up of questions very illuminating. … Here lies a difference of opinion. I think that such splitting up does not do justice to the explanations given by biologists. Although in research practice complex questions are tackled by splitting them up into a number of questions, in the resulting answers to complex questions the separate questions are brought into a connection that provides more insight than the sum of the separate answers as you give them.

This I fail to see, at least in the case of electric fishes. Of course, the answers have to be put together in an appropriate way, which is usually more than mere concatenation. This may require an appeal to covering principles, such as the transitivity of causal claims in the case at hand. However, more than such connecting principles do not seem to be needed.