Explanation by Specification

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1. *Introduction*

The standard view on explanation of individual facts, such as events and states of affairs, is that of explanation by *subsumption* under a law or theory in combination with one or more so-called initial conditions. Formally, the underlying argument uses the rule of inference called universal instantiation (UI), followed by modus ponens (MP). That is, the most elementary form of subsumption explanation is given by the valid argument:

(1) $\forall x(Ax \rightarrow Bx)$	law-premise
(2) Aa	initial condition-premise
(3) $Aa \rightarrow Ba$	from (1) by UI
Ba	from (2) and (3) by MP

According to the subsumption view, the search for, and the establishment of the law and the initial conditions form the synthetic part of the explanation. The resulting valid argument forms the analytic part: when the real work has been done, the purported train of thoughts is put in the opposite direction, leading to the alleged underlying argument.

As is well known, the explanation of an empirical law, or even a theory, can be reconstrued along the same subsumption lines with, of course, some plausible modifications. Moreover, besides the deductive versions there are probabilistic and approximative versions of the subsumption model. Together these various versions of subsumption explanation account, in our opinion, for a large part of explanation in the empirical sciences.

However, the indignant criticism of interpreting certain types of explanation along these subsumption lines has never stopped. In particular, intentional explanations of human actions, as in history for example, and functional explanations of biological traits have frequently been mentioned as examples of explanations that do not conform to the subsumption pat-

tern. In two previous papers (LIE, LFEB)([1]) we have made a limited inventory of the objections that can be raised against subsumption explications of intentional and functional explanations. Moreover, we have proposed in these papers new explications, which are strongly similar. In the synthetic part a *specific* intentional (functional) statement, specifying the intention (function) of the action (trait), is searched and established. This allows, in the analytic part, by existential generalization, the conclusion that the action (trait) in question is intentional (functional); a non-trivial conclusion, which is quite different from the standard conclusion that the action is performed (that the trait is present). The crucial difference between intentional and functional explanation lies of course in the substantial differences in meaning between the two respective specific statements.

The present paper is based on the idea that intentional and functional explanation are (important) examples of a general type of explanation, differing from explanation by subsumption, and to be called *explanation by specification*.

In Section 2 we will describe the logical structure of explanation by specification, in which existential generalization (EG) is the crucial rule of inference. Intentional and functional explanations will serve as illustrations.

In Section 3 we will argue that a subsumption of a certain type of *causal* explanation is unsatisfactory as well, and that such causal explanations are better explicated as another special case of explanation by specification.

In Section 4 we discuss the general situation with respect to the variety of explanation that occurs in the sciences and related areas, leading to some hints for further research and to an overall survey of explanation.

Although at least some objections against various versions of the subsumption explication of intentional and functional explanation are well known, we like to conclude this section with our lists of objections against one leading example of both.

The subsumption explication of intentional explanation of human ac-

([1]) T. KUIPERS, "The logic of intentional explanation", *Communication and Cognition*, 18.1-2, 1985, abbreviated as LIE, and "The logic of functional explanation in biology", *Proceedings 10th Wittgenstein Symposium*, Kirchberg/Wechsel, 1985, Vienne, 1986, abbreviated as LFEB. A condensed and improved version of LIE appeared in the new Dutch journal called *Handelingen* (VU-A'dam), under the title "Intentioneel verklaren van handelingen".

tions has been defended by Hempel([2]). In our present view([3]) the main (mutually related) objections are:

a. no clear correspondence with research practice,
b. no difference between explanation and prediction,
c. no explicit role for intentional statements,
d. no adequate room for alternative actions,
e. irrelevance of the empirical law.

The subsumption explication of functional explanation of biological traits has been defended by Nagel([4]), and in a slightly different form by Hempel([5]). Of the five objections that can be raised against Nagel's version, the first two correspond to a. and b. above, the third and fourth are similar to c. and d., respectively; and the fifth is new and specific for functional explanations. We confine ourselves to:

c′. no explicit role for functional statements,
d′. no adequate room for alternative, i.e. functionally equivalent, traits,
e′. no evolutionary historical component.

Against the background of these objections the idea arose of a totally different kind of explication, of which we will now describe the general structure.

2. *The structure of explanation by specification*

Let Q indicate a qualification like intentional, functional, etc... In a Q-context, i.e. a context in which Q is frequently used as a qualification of something, e.g. an action or a trait, one also speaks frequently about Q-explanations. Roughly speaking, in our view, such Q-explanations concern the specification of Q. The explication of Q-explanations along this line will now be described.

The *leading intuition* of our explication is that there is a valid argument involved, but that the standardly proposed conclusion is not the cor-

([2]) C. HEMPEL, 'Aspects of scientific explanation', Section 10, *Aspects of scientific explanation*, Free Press, New York, 1965. In fact our objections apply already to a simplified version, i.e. without Hempel's premise of a rational agent.

([3]) We do no longer defend objection number 3 in LIE. In LIE we deal also with the objections against G. von Wright's practical syllogism approach to intentional explanation.

([4]) E. NAGEL, *The structure of science*, p. 403, Routledge, Londen, 1961.

([5]) C. HEMPEL, *op. cit.*, pp. 309/310.

rect one. Our *claim* is that our explication grasps the kernel of simple cases, leaving room for modifications that may be necessary for complicated cases. The explication consists of two stages. In the first stage a meaning analysis is given for the relevant statements. In the second stage the thought-process of the researcher is reconstrued including the underlying valid argument.

2.1 *Stage 1: Meaning analysis*

We start with abbreviations for the three crucial types of statements, each time followed by its intentional and functional version, respectively:

f(x,y) : factual statement
(x: subject variable; y: (partial) predicate variable),
P(x,y) : person x performed action y,
H(x,y) : organisms of type x have trait y.

Qf(x,y,z) : specific qualification statement (specific Q-st.)
(z: qualification variable, $y \neq x$),
IP(x,y,z) : x performed y with the intention z,
FH(x,y,z): the function of y of x is z.

Qf(x,y) : unspecific qualification statement (unspecific Q-st.),
IP(x,y) : x performed y intentionally,
FH(x,y) : y of x is functional.

The general idea is now, first, that a specific Q-statement, Qf(x,y,z), can be decomposed into a trivial meaning component, viz. f(x,y), and one or more non-trivial meaning components, and, second, that an unspecific Q-statement, Qf(x,y), is in fact an existentially generalized specific Q-statement. More formally, we postulate the following two (schemes for) meaning postulates:

MP−1 $Qf(x,y,z) \approx f(x,y) \,\&\, C_1(x,y,z) \,\&\, \ldots \,\&\, C_n(x,y,z)$,
MP−2 $Qf(x,y) \approx (\exists z)\, Qf(x,y,z)$.

Of course, the meaning components $C_i(x,y,z)$ in MP−1 have to be specified for each particular qualifier Q. For each type of Q this specification provides the *key* to Q-explanations (according to our reconstruction).

In LIE we have argued that the following conjunction is the key to *intentional* explanation*.

$$IP(x,y,z) \approx P(x,y) \,\&\, D(x,z) \,\&\, BU(x,y,z),$$

where the following new abbreviations have been introduced:

D(x,z) : x desired z,
BU(x,y,z): x believed y to be useful to approach z.

Similarly, in LFEB we have argued that the key to *functional* explanation in biology is

$$FH(x,y,z) \approx H(x,y) \,\&\, PC(x,y,z) \,\&\, PC(x,z,\omega),$$

with the new abbreviations:

PC(x,y,z) : y of x is a positive causal factor for z,
PC(x,z,ω): z of x is a positive causal factor for reproduction and survival.

2.2 *Stage 2: Thought-process in a Q-explanation*

First of all, the heuristic-methodological principle dominating the research in a Q-context is of course

Q-principle: if f(x,y) then Qf(x,y).

As many other methodological principles, the Q-principle is conceived as fundamentally leaving room for exceptions. Such exceptions can only improperly be called falsifications. That is, the research is guided by the idea that the qualification Q is adequate, but the research may fail to substantiate this claim. Although it is impossible to have conclusive reasons to conclude that Q is not applicable, the researcher may provisionally come to this conclusion, that is, for the time being.

Now we present a stepwise description of the thought-process governing a Q-explanation. Hopefully, the scheme speaks largely for itself. Questions and hypotheses will be indicated by questionmarks, verified statements by exclamationmarks.

* *Note added in proof.* In the meantime I came to understand that it can be justified to add a conjunct to the key for intentional explanation (see end 2.1.), stated in informal terms: the combination of the two mental components actually operated as causal factor. Similarly, it is justified to add to the key for functional explanation: the trait in question actually evolved along the suggested evolutionary lines.

Thought-process in a Q-explanation

1. Verified factual statement	f(x,y)!		
2. *Question*	why f(x,y)?		
3. Unspecific Q-st. *as hypothesis*	Qf(x,y)?	heuristic *phase*	synthetic part: *Q-specification*
4. Specific Q-st. *as hypothesis*, with non-trivial meaning-components as testimplications	Qf(x,y,z)? hence, by MP−1 $C_1(x,y,z)$? . . . $C_n(x,y,z)$?		
5.a Falsification of one C_i, go *back to step 3*	not-Qf(x,y,z)!	test phase	
b *or*, no conclusive results, go to stop 3 or 7	Qf(x,y,z)?		
c *or*, verification of all C_i, hence *answer*: verified specific Q-st.	Qf(x,y,z)!		
6. Hence, conclude first as a side-step: *verified unspecific Q-st.*	by MP−2 and EG Qf(x,y)!	deductive phase	analytic part: *Q-generalization*
7. Then go to new, related why- and how-questions.			

Our claim is of course that the *process* of producing a Q-explanation is characterized by the above scheme, that the *main product* is the corresponding specific Q-statement, and that an interesting *by-product* is given by the valid implication of the corresponding unspecific Q-statement.

Step 4 shows that the thought-process is essentially *hypothetic-deductive*: a specific hypothesis is put forward, and its main test implications are derived and tested. An important difference with the nomological standard is that the hypothesis may be of nomological nature, as in the case of functional explanation in biology, but does not need to be, as in the case of intentional explanation of human actions.

As to the by-product, the valid implication of the unspecific Q-statement, it should be stressed that this may not be important for the practising scientist. However, it has been the philosopher's conviction that there is some valid argument involved. Hence, let us lift out this valid side-argument:

5.c	Qf(x,y,z)	obtained in step 5
6.	Qf(x,y)	MP–2 and existential generalization (EG).

According to the standard view, the conclusion of the postulated underlying argument is f(x,y). In our explication it is Qf(x,y). To be sure, it follows directly from MP–1 and MP–2 that f(x,y) is a (conjunctive) meaning component of Qf(x,y). Hence, f(x,y) now forms a part of the conclusion. But it is easily seen to be a trivial part (the only one), for f(x,y) is also, according to MP–1, a conjunctive meaning component of Qf(x,y,z).

Hence, the underlying argument is essentially the following: in step 6 we conclude that f(x,y) deserves indeed the qualification Q, something which we already thought, by hypothesis, in step 3. In the meantime new information has made it clear that this hypothesis is true. In our opinion, this argument explains our intuitive feeling that everything fits, that the puzzle is solved, in case of, for example, a satisfactory intentional or functional explanation.

Of course, the rule EG is one of the most undisputed rules of inference in logic; hence, our explication cannot fall victim to criticism in this direction.

Moreover we leave it to the reader to check that the objections mentioned in Section 1 are not applicable to the specification explications of intentional and functional explantions.

Finally, we leave it to the reader to think of new questions that can be raised, in step 7, after a successful intentional or functional explanation.

3. *Causal explanations as specification explanations*

Causal explanation of events are seldomly mentioned as examples of explanation that cannot be seen as subsumption explanations. On the contrary, causal explanations are usually seen as explanations by subsumption par excellence, viz. subsumption under a causal law. However, the first point may be right, but the second may nevertheless be problematic.

More precisely, there is a certain type of causal explanations for which the subsumption interpretation is, though formally possible, not the most adequate explication. We think especially of causal explanations in the context of e.g. everyday life, jurisdiction, insurance, etc... In many cases we claim that one of the causal factors was *the cause*, whereas the subsumption view is essentially neutral with respect to the causal factors.

The following examples are all of the suggested kind, to be called *accidental causal explanations*:

- her childbedfever was caused by "cadaveric matter" (well known from Hempel's report of Semmelweis's discovery),
- the catastrophe with the Challenger was caused by a leaking packing,
- the fire was caused by a short-circuit,
- the cause of his death was a heart-attack,
- the cause of the accident was that the driver passed red traffic lights.

The 'neutrality-objection' against the subsumption view specifically applies to (accidental) causal explanations, but it is nevertheless related to some other objections which are roughly similar to those mentioned in the context of intentional and functional explanation. To begin with, research practice is everything but making an undifferentiated inventory of all causal factors. Second, again there should be difference between explanation and prediction, but now in the opposite direction: to predict the event in question it is sufficient to know all causal factors and the relevant causal law. To explain it, it is moreover necessary to be able to select the one cause among all causal factors. Third, and finally, there is no explicit role for causal statements in this case. Note that we do not mention an objection in terms of alternative causes. Causal subsumption explanations happen to leave room for them.

In sum, the main objections against "causal subsumption" are:
a. and b. (Section 1),
c''. no explicit role for causal statements,
d''. neutrality with respect to the causal factors.
In the light of these objections it is plausible to try to explicate accidental causal explanations as a subtype of explanation by specification. To this we will turn now, following roughly the order of Section 2.

The following abbreviations will be used:

O(x,y) : event y occurred to system x,
CO(x,y,z) : y occurred to x due to cause z,
CO(x,y) : y occurred to x due to some specific cause.

The five examples of causal explanation mentioned above are all formulated in terms of the second type of statement, i.e. CO(x,y,z). For such statements we propose the following key, i.e. specification of MP-1 of Section 2:

$$CO(x,y,z) \approx O(x,y) \;\&\; AO(x,z) \;\&\; \exists f_1 \ldots f_n \,(\&_i NO(x,f_i) \;\&\; CL(x,y,z,f_1 \ldots f_n))$$

where the following new abbreviations are used:

$AO(x,z)$: $O(x,z)$ & z is an *abnormal* factor (event, intervention, condition) for x,

$NO(x,f_i)$: $O(x,f_i)$ & f_i is a *normal* factor/condition for x,

$CL(x,y,z,f_1 \ldots f_n)$: "if $O(x,z)$ and $\&_i O(x,f_i)$ then $O(x,y)$" is a *causal law* in the specific sense of Nagel(6), that is:

- it is an empirical law
- z and the f_i are space-and-time-contiguous
- there is time-asymmetry: z precedes y.

It is easy to check that the proposed key is in agreement with MP-1. By consequence, MP-2 makes sense as well.

The presented key takes causal statements, and hence the corresponding causal specification explanations, as (primarily) reporting the abnormal causal factor among all causal factors. Hence, they apply only if there is at least one abnormal factor. In other words, the relevant *causality principle* says that there is always an abnormal factor operating, and it is likely to have exceptions.

It is now easy to fill in the thoughtprocess for a causal specification explanation, including suggestions for new questions after a successful closure of the thoughtprocess. All this will be left to the reader.

A number of remarks have to be made.

1. Again our claim is only that the specification-explication grasps the core of relatively simple examples of what we have called accidental causal explanations, leaving room for complex cases.
2. It is easy to check that all four objections discussed in the beginning of this section do not apply. In particular, the specification is non-

(6) E. NAGEL, *op. cit.*, Section 4.V. "Empirical Law" is of course to be understood in the sophisticated sense, i.e. its descriptive terms may be laden with theories, but not with theories pretending to explain the law or with the law itself.

neutral with respect to the causal factors, it is biased in the direction of the abnormal factor (if there is any).

3. A causal specification explanation implies the possibility of providing a causal subsumption explanation, but not the converse. More precisely, the converse holds if and only if one of the causal factors is abnormal. In this respect a causal specification explanation is quite different from intentional and functional specification explanations. The latter do certainly not imply the corresponding subsumption explanations, if there are such things at all.
4. In general, "the cause" z will be, relative to $f_1 \ldots f_n$, a so-called INUS-condition in the sense of Mackie([7]): an Insufficient but Necessary part of a condition which is itself Unnecessary but Sufficient (for the occurrence of y). More precisely, U and S are already guaranteed, I and N need not always be satisfied.
5. The distinction normal-abnormal is of course vague, but in many contexts and cases it is easy to reach agreement on what the abnormal factor was, or what the abnormal factors were, for there may of course be more than one.
6. The question "Why O(x,y)?" is usually raised because the event to be explained, i.e. y, is abnormal (AO(x,y)), but this is no meaning component of CO(x,y,z).
7. A causal specification explanation of an individual event can be generalized to an explanation of a regularity (e.g. the Semmelweis-example).
8. We do not claim that the abnormality view on causal explanation is new, what is new is the specification perspective.
9. As already mentioned, the relevant causality principle should leave room for exceptions. Compare e.g. dying from a heart attack or "due to old age", in the second case there is supposed to be no substantial abnormal factor. Hence, the methodological causality principle should not be confused with some kind of universal determinism (roughly, for every event there is a number of causal factors that are jointly sufficient). The causality principle is compatible with determinism as well as with (occasional) indeterminism.

([7]) J. MACKIE, "Causes and conditions", *American Philosophical Quarterly*, 2.4, 1965.

4. *A survey of explanation*

In the foregoing section we saw that an explanation by causal specification implies the possibility of an explanation by causal subsumption. For other types of explanation by specification, such as intentional and functional ones, there is not at all such a strong implication. However, it is important to note that they neither exclude the coexistence of subsumption explanations. By consequence, our general explication has, again, nothing to do with (in-)determinism.

In our view the situation is as follows. In certain contexts of scientific interest we happen to focus on certain types of explanation. Scientists are not always interested in explanation by subsumption, although it is certainly true that successful explanations of (in particular) regularities by subsumption under a theory are very important in both the natural and the social sciences. But besides interest in subsumption in many cases, one is frequently also, or even only, interested in specification. For example, put in our new terms, biologists are many times primarily interested in explanation by functional specification, historians in explanation by intentional specification, insurance companies in explanation by causal specification.

By way of slogan one might say: although explanation by subsumption may in principle be always possible, it is certainly not always interesting; on the other hand, explanation by (some relevant) specification is certainly not always possible, but, as long as the answer is not well known, it is always interesting when it is possible.

Interest in certain types of explanation is not only a matter of individuals and concrete cases. A scientific community may favour a certain type, in which case it is likely to form a substantial part of its style of thought. More awareness of such, in our opinion, defensible differences in thought style between communities working in roughly the same area, may not only elucidate many communication problems between these communities, but it may also be a useful point of view in sociology of science.

In line with this we like to draw attention to the fact that there will be other subtypes of explanation by specification. Specifically, our explication raises in particular the question whether there are "clear and distinct" subtypes of explanation by specification between intentional explanation on the one hand and functional explanation in biology on the other. To verify this conjecture, further research may lead to proposals

for the corresponding *keys* of these subtypes. In psychology one might think of a key for explanation by (specification of) unconscious motives. In sociology and anthropology there may be specific keys for functional explanation, which are not strictly biological. However, it may also be that there is just a diffuse, continuous path from biological functional explanation to intentional explanation.

We like to conclude this article with the suggestion of Rick Looijen to construe explanation by subsumption as a special subtype of explanation by specification, roughly along the following line: some fact can be explained by subsumption if there are one or more laws and initial conditions such that etc... If deterministic laws are taken as the ideal, the corresponding "principle of subsumptability" can better be called "principle

Survey of explanation

Explanation by			
subsumption	causal	functional	intentional
specification			
governed by the methodological principle of			
determinism	causality	functionality	intentionality
with important areas of application			
natural, and social sciences	natural, social and medical sciences, technics jurisdiction insurance everyday	biology sociology psychology	everyday history economics psychology

of determinism", for which one may, or may not, leave room for exceptions.

This suggestion is included in the following survey of explanation([8]).

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([8]) I thank Rick LOOIJEN for his stimulating remarks on earlier versions.