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Not All Explanations Predict Satisfactorily, and Not All Good Predictions Explain

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Abstract

This short comment on Epstein's (2008) paper and on the response by Thompson and Derr (2008) argues that the symmetry between explanation and prediction cannot satisfactorily be discussed without making clear what prediction means—depending on which connotations the authors have with 'prediction' their arguments can or cannot be accepted.

1.1

Both Epstein (2008) and the authors of response (Thompson and Derr 2008, this issue of JASSS) miss one important point: Both take "prediction" as a term with a fixed and unambiguous meaning—which it is not. Epstein seems to understand prediction in the sense this word has in the sentence "the orbits of the planets will never be predicted." By the way, in this argumentation he forgets that 2000 years before Newton solar and lunar eclipses could be predicted with surprisingly high precision with a model which we now find wrong (which means that a good prediction is not necessarily a good explanation). Thompson's and Derr's reply accepts a much weaker meaning of "predict" as they call "earthquakes occur" a prediction (for which no theory is necessary, after the first earthquake that ever occurred it was clear to humankind that such things happen). Of course, the predictive power of plate tectonics is even higher as it predicts that in certain parts of the planet earthquakes will be more frequent than in other regions. This finding makes it necessary to argue that there are at least three different meanings of prediction, namely as an answer to three quite different questions (see Troitzsch 1997, p. 46):

1. "Which kinds of behaviour can be expected [from a system like this] under arbitrarily given parameter combinations and initial conditions?
2. Which kind of behaviour will a given target system (whose parameters and previous states may or may not have been precisely measured) display in the near future?
3. Which state will the target system reach in the near future, again given parameters and previous states which may or may not have been precisely measured?"

1.2

With this distinction between different kinds of prediction, the controversy between Epstein and his critics is easily ended: Any kind of good explanation, under all circumstances will yield a prediction of type 1 (and perhaps also of type 2), but not every good explanation will yield a prediction if type 3. The prediction of type 3 can even be subdivided in a stochastic or statistical version and a deterministic one (see Troitzsch 1997, p. 46-47):

3a
: Which are the expected value and the confidence interval around the expected value of the state the target system will reach in the near future, again given parameters and previous states which may or may not have been precisely measured?

3b
: Which exact value will the state of the target system have at a certain point of time in the near future, again given parameters and previous states which have been precisely measured? (This version was not even mentioned in Troitzsch 1997 and seems to be excluded in Epstein's paper, paragraph 1.8, as well!)

The prediction of a solar or lunar eclipse is obviously of type 3b, as everybody knows who ever observed one of these phenomena. The prediction of the temperature at some time during the next few days is obviously of type 3a, as we know from weather forecasts on the TV (where they usually show the trajectory of the expected temperature for the next few days, surrounded by a funnel which shows the growing confidence interval).

1.3

But there is another claim to make: it is not the case that Carl Hempel's symmetry hypothesis was never contested. Some fifty years ago there was a long discussion (see Scriven 1959 and Grünbaum 1962, and see also Stegmüller 1966, where he points to the vagueness and ambiguity of the terms explanation and prediction, and Stegmüller 1969, chapter II, with a very detailed analysis of explanation, retrodiction and prediction). Hempel's argumentation with respect to the symmetry thesis after this discussion (Hempel 1965) is much more detailed, and he argues only that an adequate explanation is a *potential* prediction (a thesis which he defends strongly) and that an adequate prediction is a *potential* explanation (here he is more retentive, in principle accepting that the precise predictions of solar eclipses by ancient astronomers were based on wrong explanations). The problem here is the word "adequate". It is quite obvious that his notion of adequacy is similar to Zeigler's (1985, p. 5) "structural validity" since whenever a model is structurally valid ("if it not only reproduces the observed real system behaviour, but truly reflects the way in which the real system operates to produce its behaviour") it can be expected to make predictions of any of the types 1 through 3a (of type 3b only in the entirely deterministic case)—but even non-adequate explanations are potential and even good predictions: see the case of solar and lunar eclipses predicted by Babylonian astronomers.

1.4

In the case of living, cognitive and social systems (and in other complex systems as well) cause-effect relations are rarely as simple as in the examples referred to by Hempel, Grünbaum, Scriven and Stegmüller mentioned above (their arguments are mainly about artillery, astronomy, hydraulics, only Scriven refers to medicine, namely the case of late symptoms of a particular disease which may or may not occur—but Scriven is rather an opponent of the symmetry thesis). In these complex systems sometimes the same effect can be produced by different combinations of different causes (see the discussion in Hempel 1965, footnote 46, where he argues that in the medical cases referred to by opponents of the symmetry thesis the available information is often not sufficient to explain the observed outcome). And this is in line with Epstein's argumentation that "Explanation Does Not Imply Prediction"—if and only if we interpret Epstein's prediction as a prediction of type 3b; if we restrict the meaning of prediction to type-1 or type-2 prediction, then a claim that an explanatory theory can predict is certainly possible.

1.5

If we have a closer look at Thompson's and Derr's argumentation about earthquakes (and the same applies to Epstein's two other examples and the examples discussed between Scriven, Grünbaum, Hempel, Stegmüller and others fifty years ago), we will see that a potential deficiency of both explanation and prediction is not (only) a deficiency of the respective theories but rather a deficiency of our knowledge of the complicated antecedents of the events to be explained or predicted: That we "can neither explain nor predict that an earthquake of specific power will occur in a specific place at a specific time" is mainly because we do not have sufficient information about the exact shape of the neighbouring plates, their speed, their temperature, the pressure that they exert on each other, their viscosity and so forth. If we had, it would still be impossible to make a prediction of type 3b, but a prediction of type 3a might be more precise and thus more valuable, but it is very doubtful that all these characteristics of some matter several kilometres below our feet will ever be measurable to any useful degree of precision. And in a way this resembles the situation of those who want to explain why a crash in the stock market occurred or who want to predict when such a crash will occur. In agent-based simulation of a stock market a crash will easily be predicted (as the simulation proceeds) and will easily be explained (as the computer simulation makes all data available, as we can "look into the minds" of our software agents), but even if the model were structurally valid in Zeigler's sense we have no chance to initialise the simulation model with an exact image of all the knowledge, beliefs, desires and intentions of all the brokers, shareholders, buyers and sellers involved in a stock market, and we would arrive at a prediction of type 2 at best.

1.6

But this problem, too, was already seen by Hempel (1965) when he commented on Scriven's argument. Hempel concedes that sometimes only the occurrence of the event to be explained reveals that the conditions laid down in the explanans were fulfilled. Thus if an event is to be predicted we still lack the information whether (all of) the antecedent conditions are fulfilled. From Hempel's point of view this is rather a practical than a logical problem, as in principle the necessary information could be provided. Thus in the end the controversy might be settled by summarising that the symmetry thesis holds from a logical point of view but not from a practical point of view.

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