Objections to Railton's Deductive-Nomological Model about Probabilistic Explanation

*Emre Arda ERDENK**

Abstract

In this paper, I will focus on Peter Railton (1988)'s "Deductive-Nomological Model of Probabilistic Explanation". First, I will initiate briefly the core of the model by means of explaining the important parts that are related to the preceding discussion of the paper. Following that, I will raise objections and criticisms to the notion of parenthetic addendum, which is the most genuine and crucial component of this model of explanation. I will claim that the addendum does not explain the causal origin of the explanandum; it brings circularity to the model and it excludes the D-N inference, when it plays the function of intermediation of two explanations. Finally, it brings the problem of epistemic relativization. In the second part, I will introduce two counterexamples to the model. The first one will show that in cases of intervening causes, explanations in this model fail to be explanatorily relevant. The second one will attack to the notion of ideal D-N-P text by claiming that it fails to contain all the necessary items of explanation in cases of instabilities. Ultimately, all these objections and criticisms will show that Railton's model faces many problems which makes it difficult to be considered as being a powerful model of singular propensity explanations.

Keywords: Scientific Explanation, Deductive Nomological Model, Hempel, Singular Propensity, Indeterminism, Philosophy of Science.

Railton'un Olasılık Açıklamalarına Dair Dedüktif-Nomolojik Modeline İtirazlar

Özet

Bu makalede Peter Railton (1988)'un "Olasılık Açıklamalarına dair Dedüktif-Nomolojik Model'ine odaklanacağım. İlk olarak makalenin ilerleyen tartışmaları için gerekli olan, modele dair önemli kısımları ortaya koyacağım. Buna müteakip, modelin en orijinal ve kritik parçası olan parantez eklentisi kavrayışına dair itiraz ve eleştirilerden bahsedeceğim. Eklentinin açıklana-

* Yrd. Doç. Dr., Karamanoğlu Mehmetbey Üniversitesi, Edebiyat Fakültesi, Felsefe Bölümü.

nın nedensel kökenini açıklamadığını; modeli fasit döngüye soktuğunu ve iki açıklama arasında köprü vazifesi görmesi halinde D-N çıkarımını devreden çıkardığını iddia edeceğim. Son olarak da bilgisel görelilik problemi yarattığından bahsedeceğim. İkinci bölümde, modele yöneltilen iki karşı örneği ele alacağım. Bunlardan ilki, sonucun oluşması esnasında olaya müdahil araya giren nedenlerin olduğu durumlarda, bu modelle yapılan açıklamaların açıklanan ile ilgisizleştiğini gösterecektir. İkincisi ise, kararsız durumlara dair modelin getirdiği açıklamaların modelin ideal D-N-P metnine dair problemler nedeniyle açıklamada bulunması gereken zorunlu kısımlar hususunda eksik kaldığı yönünde olacaktır. Bütün bu eleştiriler ve itirazlar ışığında Railton'un modelinin tekil eğilimli istatistiksel olayların açıklanmasına dair güçlü bir alternatif oluşturmadığını savunacağım.

Anahtar Kelimeler: Bilimsel Açıklama, Dedüktif-Nomolojik Model, Hempel, Tekil eğilimli istatistiksel olaylar, Belirlenmezcilik, Bilim Felsefesi.

Introduction

In this paper, I will focus on Peter Railton (1988)'s "Deductive-Nomological Model of Probabilistic Explanation". First, I will initiate briefly the core of the model by means of explaining the important parts that are related to the preceding discussion of the paper. Following that, I will raise objections and criticisms to the notion of parenthetic addendum, which is the most genuine and crucial component of this model of explanation. I will claim that the addendum does not explain the causal origin of the explanandum; it brings circularity to the model and it excludes the D-N inference, when it plays the function of intermediation of two explanations. Finally, it brings the problem of epistemic relativization. In the second part, I will introduce two counter-examples to the model. The first one will show that in cases of intervening causes, explanations in this model fail to be explanatorily relevant. The second one will attack to the notion of ideal D-N-P text by claiming that it fails to contain all the necessary items of explanation in cases of instabilities. Ultimately, all these objections and criticisms will show that Railton's model faces many problems which makes it difficult to be considered as being a powerful model of singular propensity explanations.

1. Railton's D-N-P Model of Probabilistic Explanation

Peter Railton (1988)'s influential model of scientific explanation for genuine probabilistic process in nature is designed to explain singular events, which happens by means of probabilistic processes in nature. His model is an alternative to inductive-statistical (I-S) model of scientific explanation (Hempel, 1965). Instead of Hempel's I-S, Railton's deductive nomological and probabilistic model (D-N-P) explains such phenomenon by means of deduction using probabilistic laws and initial conditions of the occurrences of such chance events. (Railton, 1988: 206-26) In terms of its deductive and nomological nature, this model was seen as a particularly unique model, which expresses a significant departure from the old formal and ordinary language models[1].

Railton points out that the explanandum in question must be irreducibly probabilistic and no deterministic process can explain it. Here, he accepts the general interpretation of the quantum mechanics and consequently commits himself to the physical necessity of chance events in the nature[2]. One may not adopt this interpretation of quantum mechanics and commits to other interpretations such as many-worlds (Everett, 1957) or consistent histories (Griffiths, 1984) interpretations of quantum mechanics. However, as Railton's model depends on the general interpretation of quantum mechanics we may not need to worry about whether his physical foundation is reliable or not[3].

Railton underlines that a D-N-P model of explanation should meet the following criteria. Firstly, a probabilistic explanation must either be true or false and that should be independent of the present epistemic situation. Secondly, it must be true. Truth of the explanation is grounded by the validity of the argument and the true conclusion must follow true premises. Finally, probabilistic laws must also be true and the process responsible for the explanandum must be genuinely indeterministic (Railton, 1988:124). Railton's D-N-P can be schematized as the following:

(1) A derivation of the law (2) from the theoretical account of the indeterministic process.

(2) The probabilistic covering law: 'At any time, anything that is F has the probability p to be G'.

(3) The relevant circumstances: 'e is F at time t0'.

(4) The statement of the probabilities of occurrence of the event in question: "e has the probability p to be G at time t0".

(5) Finally, a parenthetic addendum, which states how things turn out: 'e did/ did not become G at t0'. (Ibid:127-128)

This D-N-P model consists of three main components: two deductive steps and then a parenthetic addendum. First deductive step is the deduction of a statistical law (2) from the relevant probabilistic theory (1 to 2). Second one (2 to 4) is the deduction of the probability of the explanandum (4) from the explanans,

---

1 Apparently, reader must understand that what I mean by old formal and ordinary language models are those of early positivist models of scientific explanation.

2 By the general interpretation I refer to Bohr & Heisenberg interpretation of quantum mechanics; namely the standard or the Copenhagen interpretation of quantum mechanics (Cf. Howard, 2004).

3 Somewhat this may be a good topic for another paper. If the explanandum is not irreducibly probabilistic (as the many-worlds interpretation suggests) or a deterministic process may explain it, then Railton's model would be completely out of the game. However, this paper only interested in the internal inconsistencies of Railton's model.

which consists of the statistical law (2) and from the relevant initial conditions (3). The steps of (2), (3) and (4) reflect the D-N inference to the probability of event's occurrence in a Hempelian framework (Hempel & Oppenheim, 1948; Hempel, 1965). To recollect the idea of Hempel's D-N model, these steps contain laws, the explanans have empirical content and the sentences constituting the explanans are true (Kicther & Salmon, 1989:12).

However, the argument (1 to 4) is not enough for an appropriate explanation. The D-N inference (1-4), Railton says, "gives … only of the fact that [the explanandum] had such-and-such a probability to occur during the interval in question" (Railton, 1988:125; the part in bracket added). As D-N-P would be incomplete just by using a mere D-N inference, Railton maintains that a parenthetic addendum (5) is required in addition to the D-N inference. For the parenthetic addendum, Railton reports, "the parenthetic addendum fills this gap in the account, and communicates information that is relevant to the causal origin of the explanandum by telling us that it came about as the realization of a particular physical possibility" (Ibid:127). So the parenthetic addendum is necessary because it brings information about the causal origin of the explanandum. More precisely, it connects a D-N-P explanation to another one by the parenthetic addendum because the only 'non-probabilistic premise' in the explanation lies on it. Railton underlines this by stating that in the case of the alpha-decay example (Ibid:125) it would be impossible to move to an account of "what the alpha-decay did to a nearby photographic plate" without the parenthetic addendum, "but only to a probability that this account will be true" (Ibid:127). So the role of the parenthetic addendum appears to be more than an addendum but in Railton's words a 'non-probabilistic premise'. I will come to the discussion of this issue in the next section.

Before that, I need to point out Railton's distinction between ideal explanatory text and explanatory information as well. Ideal explanatory text of a given physical phenomena provides all the explanations of causal and nomic connections that are relevant to the occurrence of the phenomena. On the other hand, explanatory information brings no explanation of such connections but gives some information about the occurrence of the event in question. In this case, Railton exemplifies the D-N-P model explanation of the alpha-decay of a particular uranium particle as a candidate of an ideal D-N-P text, whereas he considers explanations such as "Geiger counter is clicking because it is near a uranium-bearing rock" as explanatory information. (Railton, 1981:240) While distinguishing these two types of accounts of information, Railton also thinks that explanatory information have a non-zero weight of explanation and hence they are included in the ideal explanatory text (Ibid:241). Their role, however, is only supportive but not suggestive. In addition to this, the relevance of the explanatory information is also determined by the ideal explanatory text itself. So, the ideal D-N-P text, when constructed ideally, should explain all the relevant questions and the mechanisms essential for the explanandum. In the next two sections, we will see why the D-N-P model is problematic in terms of being an adequate explanation model.

2. The Issue Concerning the Parenthetic Addendum

In the last section, I emphasized the role of the parenthetic addendum in terms of the highlights that Railton points out for us. However, because Railton himself did not give a broad explanation of its role, it remains unclear, what the significance of the addendum really is. In this section, I will raise several objections to the use of this addendum in the D-N-P model and refers to some preexisting criticisms.

Salmon reflects the crucial worry concerning the addendum in "Four Decades of Scientific Explanation". (Kitcher & Salmon, 1989: 154-166) As Salmon points out, if the addendum is an additional premise for the D-N inference, then the explanation would be 'trivially circular' (Ibid:156). The parenthetic addendum gives the information that "e did/did not occur", but the why question of the explanation is: "why e did/did not occur?" So, it seems that if it were an additional premise then we would not consider that the D-N-P model is a proper scientific explanation. However, this worry is misleading. Railton says that the addendum is not a premise of the D-N inference. We may accept that it is not a premise of the inference of the explanation. However, if we do so, there appear more striking issues concerning the notion of the addendum.

Firstly, the content of the addendum does not explain anything. It states independently whether the explanandum is instantiated or not. However, if we remember Railton, he claimed that the role of the addendum is to give the relevant information concerning explanandum's 'causal origin'. However, it seems clearly that it does not serve any such means. There are of course reasons why it fails to serve this mission. Railton remarks, "The parenthetic addendum … is the explanandum, and yet it in no way follows from the other premises. … Presumably, we knew that 'the occurrence of G' before any explanation was offered, and so step 2e (5) brings no news" (Railton, 1981:236)[4]. Two very crucial things are present here. First, Railton admits that the addendum is the explanandum itself. Second, he confesses that the addendum brings 'no news'.

For the latter issue we should ask, if it brings no news to the explanation how come can this be bringing information concerning the 'causal origin' of the explanandum? Clearly it cannot. These two testimonials are inconsistent and reflect that Railton confuses himself too. For the former issue, if the addendum is

4 The phrase 'the occurrence of G' part is the paraphrase for Railton's terminology and 5 in parenthesis is the corresponded number of 2e in this paper.

the explanandum itself (and indeed it is), then why do we explain the explanandum by using the explanandum itself in the explanation? This reflects that the D-N-P model, by the addition of the addendum becomes self-explanatory.

Of course, this last point brings many problems. Firstly, John Lucas (1985) states, "The dominant, and I suggest correct, view is that the explanandum must be known to be true independently of the explanans. Further, it is difficult to see how the explanandum itself can have explanatory value unless we allow either partial or total self-explanation". (Lucas, 1985:52) In Lucas's criticism there is a misunderstanding. This dominant view, that he refers, can work only for explanations as arguments. However, Railton's D-N-P model is an 'explanatory account' and not an argument (Railton, 1988:127). However, this criticism may still work for the D-N-P as well because, after all, the addendum is also an explanans and without its realization, according to Railton, these chance phenomena cannot be explained. So, Railton must accept at least partial or full self-explanation, but if this is the case, then we may suspect that D-N-P's explanatory power is weaken by this addendum itself.

Second issue of the addendum is the following. As Railton himself points out the parenthetic addendum of a D-N-P explanation (of p) works as a 'non-probabilistic premise' when we need to explain other events affected by the occurrence of p, which are causally linked to p. However, in its own model the addendum is not a premise. How could it be possible –for the sake of logic- that it is not a premise of one explanation (of p), but becomes a premise, which links two explanation, in another explanation (of q)? The absurdity remains because of two reasons. Firstly, it should be a premise or not and cannot be both at the same time. Secondly, even if we ignore this problem, the truth-value of the addendum is independent of the D-N inference. In terms of this, the other explanation (of q) may use the addendum independent of the D-N-P explanation of p. There is nothing which links D-N inference and the addendum by virtue of any inference rules. Ultimately, I think that these problems weaken the feasibility of the D-N-P model of explanation.

Even if we suppose that all these problems can be ignored or solved, there we would have other related issues. Firstly, if we use the addendum as a 'non-probabilistic premise' explaining q, then the ideal text of q's causal history would consist of many self-explanatory items or at least there would be no unity in the ideal text. Such a text would merely reflects an explanation which roughly says: *such-and-such had occurred and such-and-such had not occurred and q had occurred; additionally* (by means of simple addition and not logical conjunction) *they did occurred or did not occurred with such-and-such probabilities*. It seems to me that an ideal text, for Railton, should have explained more than this in terms of the history of causal origin for q's occurrence, but it seems that it could not have succeed in doing that.

Finally, I want to refer to Railton's concern about the epistemic relativization. He claims that D-N-P model is 'free from relativization to our epistemic situation' (Railton, 1988:129). It seems to me that this holds for the D-N inference in the model but not for the parenthetic addendum. D-N inference is safe because it is deductively valid and the probabilities are ontic probabilities. On the other hand, the addendum as the explanandum cannot be free of relativization. Firstly, let's say a chance event e did not occur and we want to explain the causal origins of e. In this case, a D-N-P model containing the addendum (e did not occur) would not be explanatory because the 'the peculiar nature' of probabilistic events would not shock us in terms of e's non-occurrence. In other words, it is highly expectable that it will not occur. This means that in order to give an explanation for singular propensities, the event should have occurred already. However, this reflects some sort of epistemic relativization. Let's imagine that e has such a low probability and its occurrence is almost a miracle. In every situation of its non-occurrence nobody would try to explain why it did not. Just in the case of its occurrence we would try to explain it. However, what if it would not occur till the occurrence of another Big Bang? In such a case we would not know whether it will occur or not, and consequently we would have no ideal D-N-P text. The verb 'know' is important here. 'To know' is an epistemic term and cannot be used in ontological claims. Thus, in such situation, if we are bounded to our knowledge of 'e's occurrence', then we are making an epistemic relativization and consequently, the parenthetic addendum should always be restricted in terms of our current epistemic situation.

All these problems related to the need of parenthetic addendum reflect the ambiguity of the explanatory power of the D-N-P model and the textual peculiarity concerning the addendum as a premise or not. In terms of this, I conclude this section by saying that the notion of the parenthetic addendum alters the D-N-P model explanations.

3. Two counterexamples to Railton's D-N-P Model

In this last section, I will introduce two counterexamples to D-N-P model, which show that the model is not explanatory in some cases. Firstly, I will mention the "intervening cause counterexample", which is argued by Stuart Gluck and Steven Gimbel (1997) and secondly, I will elaborate another example that I constructed it by modifying Robert Batterman (1992)'s counterexample to Railton's D-N ideal text.

a. The Intervening Cause Counterexample

Gluck and Gimbel's main point in their counterexample is to find an intervening cause, which is statistically irrelevant but explanatorily relevant to the occurrence of an irreducibly probabilistic event. They modify the Schrödinger's cat in such a way that in the box there is a poison dispenser connected to the randomizer (A). When A is initiated, a detector in A is activated for a period t. At the same time, there is a quantum system in A with a probability of .5 of decaying during t. When the detector detects a particle, then it sends a signal to a delay timer connected between A and the gas dispenser. After 11 hours and 50 minutes, the delay timer sends the signal to the dispenser, and the gas kills the cat. If there is no decayed particle detected, then nothing happens. In addition to A, there is another randomizer (B), which works independently. B contains the same quantum system and a detector. The detector, however, also measures the spin of the detected particle. Spin-up and Spin-down have the same probability. If there is no particle, then B does nothing. If a spin-up particle is detected, then B sends a signal to the delay timer. If the timer is activated beforehand, then B deactivates the timer. If not, B does nothing. If a Spin-down particle is detected, then B sends the same signal but also it sends an impulse to the metal floor of the box, and the cat is electrocuted. Now let's suppose, A is initiated. Then the appropriate D-N-P explanation would be the following:

(n) A derivation of (o) by appeal to the relevant quantum mechanical and biological theories and the mechanisms of the entire system (including both A and B).

(o) Whenever the button on an A randomizer in this type of system is pushed at time t, there is a .5 probability of the cat dying within 12 hours of time t.

(p) The button on A was pushed at time t and there was a cat in the box.

(q) The cat had a probability of .5 of dying within 12 hours of time t.

(r) (The cat did die within 12 hours of time t.) (Gluck & Gimbel, 1997: 695-696)

The intervening cause of the death of the cat enrolls to the scenario in the following manner. Suppose, during the 11 hours and 50 minutes, B is initiated and a Spin-down particle is detected. So, the delay timer, which has been activated by A is deactivated by B and a signal is sent to the metal floor and the cat is electrocuted. In the explanation above B is included in (n) so it is a part of (o). Thus, this explanation should be appropriate to explain the death of the cat.

So all the requirements for a D-N-P explanation is met: "the probability cited in the conclusion (q) remains correct, the law (o) is true, and the inference is valid, as the derivation (n) takes in to account the possibility of B's activation" (Ibid:697). In spite of the fact that it is a true D-N-P explanation, it is not the right explanation, because the real cause of the death of the cat plays no role in the explanation. The initiation of A is stated as the cause of the death, but actually the real cause is the initiation of B because the cat is electrocuted and not poisoned.

This counterexample is an application of the intervening cause problems for the other models. It turns out that Railton's model faces the same problem in such cases. Thus, it does not credit factors, which are statistically irrelevant but explanatorily relevant and important.

b. The Counterexample of the Euler Strut to ideal D-N-P text

Batterman in his original cases criticizes the ideal D-N text and not the ideal D-N-P text by pointing out examples containing unstable equilibrium and instability. His main claim is that when filling the ideal text with all D-N inferences we may fail to explain the mechanisms at work of a particular event because such mechanisms may not involve causally in the occurrence of that event. In this paper, I will adopt his central claim and modify his example of the Euler strut (Batterman, 1992:335) to an irreducibly probabilistic case. So, it will show that the ideal D-N-P text bears the same problem.

> Euler strut is a fairly stiff ribbon of steel mounted vertically and rigidly on the floor. Suppose that we begin gradually to apply weight symmetrically to the top of the strut. Once the load reaches a critical value, the Euler critical point, the strut will buckle. That is, it will come to rest in a new equilibrium state –having buckled either to the left or to the right (Ibid).

Given this situation, we may ask the why question: "Why did the strut buckle to the left instead of right?" First of all, at the critical point, the system is in a state of unstable equilibrium. "It exhibits a form of *dynamical instability*" (Ibid:336). In addition to this, the situation is symmetrical. In terms of this there is a .5 probability of the strut to buckle to the left or to the right. However, as Batterman states the *dynamical instability* and the condition of symmetry is not sufficient enough to explain the strut buckling. According to the relevant equations of the Euler strut, the system can remain in unstable equilibrium state at the critical point indefinitely (Ibid). This means, in principle that it may not buckle. Although there is this theoretical possibility, in reality we do not observe this. We observe that it buckles with .5 probability to the right or left. The reason of this is that the external factors, even the slightest push, can buckle the strut in an equilibrium state. So, external factors plays crucial role in the explanation of this why question.

So far, the system is not irreducibly probabilistic. Now, we have to modify it in order to be a case for D-N-P explanation. For this purpose, we may assume that there is only one external factor, which affects the strut, and that is a quantum system processing on the other side of the world (adopted from the butterfly effect). This system has a .5 probability of decaying during a certain time interval. When it decays a particle starts a causal chain of molecular collision, by which, at the end, an air molecule pushes the strut to buckle to the left with .5 probability. The addition of the quantum system makes the situation irreducibly probabilistic because, the process initiating the chain of events is irreducibly indeterministic. Thus, an ideal D-N-P text instead of D-N is required. Railton remarks on the content of an ideal text as the following:

> … An ideal text for the explanation of the outcome of a causal process would look something like this: an inter-connected series of law-based accounts of all nodes and links in the causal network culminating in the explanandum, complete with a fully detailed description of the causal mechanisms involved and theoretical derivations of all the covering laws involved … It would be the whole story concerning why the explanandum occurred, relative to a correct theory of the lawful dependencies of the world. (Railton, 1981:247)

According to this account, our ideal D-N-P text should contain a complete account of the causal chain starting from the quantum system to the particular air molecule, which pushes the strut. In addition to this, it should include also the covering laws concerning the causal mechanisms involved and the quantum mechanical laws of the quantum system. Such an ideal text, according to Railton can explain the relevant why question here.

However, this account is not sufficient to explain why the strut buckled to the left. In such an explanation, we are restricted only to account the causal mechanisms and the indeterministic process, but then the instability of the system and the symmetry of the situation gain no role in the explanation. They should simply be discarded. However, the actual mechanism responsible for the buckling of the strut is these mechanisms and not the ones started by the quantum system. This latter is only responsible for the probability of strut's movement to the left or to the right. Batterman says, "Instability is not a causal mechanism of this kind [the intermolecular forces responsible for the collision]" (Batterman, 1992:338; the part in bracket is added). Ultimately, the D-N-P model of explanation for the Euler Strut cannot explain the explanandum in question here. Hence, this counterexample alters the power of Railton's notion of ideal D-N-P text.

4. Conclusion

In this paper, I have shown some problematic issues of Peter Railton's D-N-P model of explanation. The first part of the criticism was about the notion of parenthetic addendum. I have claimed that this notion makes the D-N-P model weaker in terms of being an adequate explanation. In the second part, I have shown two counterexamples. The first one has showed that Railton's model fails to explain phenomena where there is an intervening cause. The second one has showed that the ideal D-N-P text fails to contain all the necessary explanans in cases where there is dynamical instability and unstable equilibrium. Hence, D-N-P model should be improved in order to be an acceptable model of scientific explanation for singular propensity of irreducibly indeterministic events.

References

Batterman, W. R. (1992). Explanatory Instability. *Noûs* 26, 325-348.

Everett, H. (1957). "Relative State" Formulation of Quantum Mechanics. *Reviews of Modern Physics,* 29 (3), 454-462.

Gluck, S. & Gimbel, S. (1997). An Intervening Cause Counterexample to Railton's DNP Model of Explanation. *Philosophy of Science* 64, 692-697.

Griffiths, R. B. (1984). Consistent Histories and the Interpretation of Quantum Mechanics. *Journal of Statistical Physics*, 36, 219–272.

Hempel, G. C. & Oppenheim:(1948). Studies in the Logic of Explanation. *Philosophy of Science*, 15 (2), 135-175.

Hempel, G. C. (1965). *Aspects of Scientific Explanation and Other Essays.* New York, NY: Free Press.

Howard, D. (2004). Who Invented the "Copenhangen Interpretation"? A Study in Mythology. *Philosophy of Science*, 71, 669-682.

Kitcher:& Salmon, C. W. (Eds.) (1989). *Scientific Explanation*. University of Minnesota Press, MA: Minneapolis.

Lucas, G. J. (1985). The Explanation of Unlikely Events. *Southwest Philosophical Studies* 9, 49-55.

Railton:(1981). Probability, Explanation, and Information. *Synthese,* 48, 233-256.

Railton:(1988). A Deductive-Nomological Model of Probabilistic Explanation. Joseph C. Pitt (Ed.), in *Theories of Explanation* (pp. 119-135). New York, NY: Oxford University Press. First published in *Philosophy of Science* 45(1978), 206-22