

MEE140: PHILOSOPHY OF SCIENCE AND RESEARCH METHODS

Take Home Exam

Fall 2019

Was Three Mile Island a 'Normal Accident'? (Hopkins, 2001)

Student number: 1448

1.0 Heuristic evaluation

To conduct a heuristic evaluation is about looking at the overall quality of both the reference list, the journal it's published in, the author and the citations (T. M. Larsen, personal communication, September 2019). When we take a look at the reference list it's clearly not too short. The article is around eight pages, and the reference list contains 23 references, both books and articles. Three of the references are secondary sources which can be a systemic weakness, but mainly it's references to the primary source. About half of the references, twelve, are also books, which sometimes can be a negative factor, but doesn't have to be. It's obvious that a lot of the authors are well renowned in the field, such as Perrow, Pidgeon and La Porte, which are all published in the same peer reviewed journal as the article in question. In addition, there are also Reason, Turner and Sagan, to mention a few. Most of the references are also updated in relation to the year the paper was released. Some are a bit older, but with still relevant content to this day.

The journal it's published in, the Journal of Contingencies and Crisis Management is at Level 1, according to Norwegian Centre for Research Data (NSD, 2019). Level 1 indicates that the journal is an ordinary scientific publishing channel. The list only goes back to the year of 2004, so it's a chance the level has changed since the article was published in 2001. The publisher, Blackwell Publishing, was a Level 2 publisher in 2005 (NSD, 2019). The same goes here. Level 2 is publishing channels with the highest international prestige (NSD, 2019).

The author, Andrew Hopkins has had 12 books and 47 articles published from 1999 until 2017 (Researchers, 2019). By taking a look at this list it's clear that the books and articles he has published is relevant to his field. By a fast Google search, it is easy to see that he is well respected in the field, with quotes like: "... gaining recognition of the highest order in his field" (AIHS, nd).

To check the amount of citations both the author and the article have gotten, one can use the program Publish or Perish. Harzing (2016) describes Publish or Perish as: "a software program that retrieves and analyzes academic citations". When Andrew Hopkins is typed in, without any limit on publication date, 42457 citations from 996 different papers shows up. The h-index is on 89, and the g-index on 194. This doesn't tell us very much, because the search results isn't just from him. The program doesn't allow for specifications in the birth of

the author or the like, so the search is hard to limit. When Andrew Hopkins is typed in, along with the title of the article, 112 citations appear. The h- and g-index is both at 1.

He has been cited many times, but that doesn't necessarily mean that it's solely good. To find out if the citations is positively directed, I conducted a search on google scholar, with the main goal to find out in what light he has been cited. When I only searched for articles where Hopkins had been cited, with the word "review" in the title, five results showed up. This was also to reduce the number of citations that showed up in Publish or Perish the first time. One of them was an article in a level 2 scientific journal – Reliability Engineering & System Safety – which have looked at highlights from the literature on accident causation and system safety throughout history. He is mentioned in the context of normal accidents and high-reliability organizations, which shows his relevance in the field (Saleh, Marais, Bakolas & Cowlagi, 2010, p. 1109). Both Perrow, Turner and La Porte is referenced as well.

2.0 Concepts of causality

The goal with causality is to find causal explanations to how different phenomena occur. When you find such explanations, you can use them to predict future development (Williamson & Illari, 2013, p. 67-68). Williamson and Illari (2013) distinguishes between two types of approaches when it comes to causality: difference making and production. Difference making causes is about changing the associated effect, while production is about the relation between the cause and effect.

2.1 Probabilistic concept

The probabilistic concept of causation is based on that the cause increases the probability for the effect to occur (Williamson & Illari, 2013, p. 68). This is a form of difference making. For example – reducing the availability of cigarettes improves lung health, but only if the probability of the lung health being improved, increases. This kind of causation also includes issues where the cause isn't always leading to the effect. The availability of cigarettes may increase the chance of getting lung cancer, but it doesn't make it certain that one will get lung cancer. Not all causes increase the probability of the occurrence of an effect.

Evidence for this concept of causation is found in statistical correlations that are obtained through use of statistical methods. The data used in these methods come from observational studies where populations are in their natural settings. Social scientists start by measuring

correlations between different variables to see if there could be a causal relation (Cartwright, 2014, p. 314). Such statistical correlations may also occur from common causes that looks like causal relations, but really are spurious correlations. Spurious correlations occur because of a third variable that is the cause of both the correlating variables. This is a challenge with the statistical methods (Neuman, 2017, p. 46). It is also possible that causation can occur without probability-raising. For example, if a person already has a gene which make the probability for lung cancer almost 1, the probability of this person getting lung cancer wouldn't be affected by him smoking or not.

2.2 Counterfactual concept

The counterfactual concept of causation is the second form of difference making. It's normal to reason counterfactually; if he had grown up in a house without cigarettes in it, he wouldn't have started smoking. This is a counterfactual conditional, which means it's an *if-then* claim (Williamson & Illari, 2013, p. 68). The person in question was in fact raised in house with cigarettes in it, but we imagine what would have happened if the counterfactual statement was correct. But, there are a lot of other factors that may lead people to start smoking, even though they aren't living in this type of environment, so the statement simply isn't true alone (Williamson & Illari, 2013, p. 69).

A counterfactual claim will be hard to test, because you can never observe what would've happened if things where the other way around. Evidence for counterfactual causation therefor involves getting information about what would've happened if the cause was absent – if the person in question in fact hadn't grown up with cigarettes in the house. Randomized Control Trials (RCTs) is said to supposedly provide this, but the relevance is limited within the counterfactual concept. It doesn't tell for which individuals the cause was effective or don't solve the problem of establishing causation in real-life complex social settings (T. M. Larsen, personal communication, September 2019).

2.3 Interventionist concept

The interventionist concept is based on that the relation between a cause and its effect is invariant, which means it continues to hold true, even when subjected to interventions. Woodward (in Steel, 2013, p. 72-73) looks at an intervention as “an ideal experimental manipulation, that targets a single variable without directly affecting anything else”. By manipulating the cause, we can also manipulate the effect in a predictable way (Cartwright,

2014, s. 316). For example, if we increase the availability of cigarettes, we increase lung cancer. When performing a good intervention efforts must be made to try not to change any variables other than the one you want to test, in this case the availability of cigarettes. All the other variables that may lead to lung cancer has to be kept constant, or else it's hard to tell what actually caused the effect (Williamson & Illari, 2013, p. 69).

As with the counterfactual claims, RCTs can help provide information about what happens when everything, apart from the presumed cause, is held constant. RCTs help with the problems that other statistical methods face – that it's hard to know what the other causal factors are and therefor what to hold constant (Cartwright, 2014, p. 314). But, it is extremely difficult to implement this in the social sciences (or even in principle), because causal relationships can easily be affected by the slightest change in context (Williamson & Illari, 2013, p. 69). Because of this there's arguably no way to ensure the validity of the results (T. M. Larsen, personal communication, September 2019).

2.4 Mechanistic concept

The mechanistic view is a production approach. The production approach focus on the *how* (Williamson & Illari, 2013, p. 69). The mechanistic concept is based on that there's a continuous process between a cause and its effect. A good way to show if there is a relation between a cause and effect would therefore be to trace the causal process between them (Cartwright, 2014, p. 319). If you're explaining D by referencing to A, you also have to explain B and C. In this case B and C is the lower-level causal mechanism between the cause and effect (T. M. Larsen, personal communication, September 2019).

To find evidence for the mechanistic concept one would need information about the sequences in question. "Process tracing" is a method for determining whether the sequence is causally related, breaking the process into smaller steps and looking at the relation between the steps (T. M. Larsen, personal communication, September 2019). One example may be if you look at the process on how the chemicals in cigarettes lead to lung cancer (Cartwright, 2014, s. 319). But this concept doesn't come without challenges. The first challenge is to separate the non-causal sequences with the causal ones. This can be a long process in itself. The second challenge is where there is causation without mechanisms. If me don't watering my plant caused it to die, there is no mechanism between me forgetting to water and the plant dying (T. M. Larsen, personal communication, September 2019).

3.0 Causal claims

3.1 Probabilistic claim

The first causal claim I want to discuss is a probabilistic one: *“As our technological systems become increasingly extensive and complex, the possibility grows of some accidents arising from the properties of the system as a whole, often as a result of unforeseen interactions which involve several organizations”* (Turner, in Hopkins, 2013, p. 66). This is categorized as a probabilistic claim because it indicates that the extensiveness and complexity in technological systems increases the probability of the occurrence of accidents.

If we look at the statement from Hopkins perspective, it isn't true, so a lot of the evidence he provides disproves the claim. Hopkins argue that no accident is inevitable, but it's the system of defenses that is inadequate (Hopkins, 2001, p. 67). The inadequate systems would be a result of Turner's theory of sloppy management, which is about how poor management is the main cause of accidents. This theory is moving away from Perrow's strictly technological views. To provide evidence in support of the claim one would therefore have to look to Perrow, even though his account for the accident is flawed. He has not taken into account the major role of the management, and how they could've prevented the accident (Hopkins, 2001, p. 68). In addition, using a statistical method to look for a causal relation between these two variables would show that in most cases they wouldn't even be correlated, because the complexity isn't the cause leading to the accidents occurring. This is as mentioned a challenge. It may look like a causal relation, but it's possible it's just a spurious correlation.

3.2 Counterfactual claim

A claim within the counterfactual concept of causality is: *“Prior to large-scale accidents there are nearly always warning signs that are missed, overlooked or ignored and that, if acted on, would've averted the accident”* (Turner, in Hopkins, 2013, p. 66). This can be seen as an *if-then* claim. If the warning signs would've been taken seriously, then the accident would've been avoided. As mentioned earlier, these types of claims are hard to test. It is impossible to observe what would've happened in this specific situation if the statement was correct, so the statement alone therefore can't be true by itself.

What can be done, on the other hand, is to look at previous similar accidents that have occurred, like Davis-Besse (Hopkins, 2001, p. 69). Gorinson (in Hopkins, 2001, p. 69)

provides an account for this almost-accident. It took place 18 months before the Three Mile Island accident, and consisted of almost the exact same sequence of events. The differences were that the operators realized the failure much earlier than at TMI, and the reactor was only at 9 percent power. Several of the engineers that worked with the reactors tried to notify the senior management about this event, but nothing happened (Hopkins, 2001, p. 69). Had the information gotten out to everyone with the same type of reactor, the TMI-accident could've been averted. Since the accident sequence was so similar between TMI and Davis-Besse, and the operators at David-Besse managed to avert the accident earlier because of the warning signs, one can conclude that the statement may be correct. If the warning signs had been noticed, the accident could have been averted.

3.3 Mechanistic claim

Turner identifies a mechanism as he states: "*Sloppy management allows various processes to operate that may nullify warnings: the normalization of deviance, group think, cultures of denial and so on*" (Turner, in Hopkins, 2001, p. 66). One can assume that if the operators had understood the warning signs or taken them seriously, the accident could have been averted, as discussed in the section above. The statement therefore implies that the sloppy management led to the accident. When he describes the underlying causal processes between the cause and effect (the normalization of deviance, group think and cultures of denial) he identifies the mechanism. He explains D, by referencing to how A led to B and C. To make sure this mechanism is correct one would have to get more information about the sequence in question. We could break the sequence into even smaller parts to see if the steps are causally related, by using the "process tracing"-method. The challenge may be to distinguish between the causal and non-causal correlating sequences.

4.0 Collectivists vs. individualists

4.1 The two disputes

It's an ongoing debate between the collectivists/holists and the individualists. The first dispute is about whether the different views are dispensable. The methodological collectivists have the view that explanations that invoke social phenomena should be a part of the social sciences and that individualist explanation can be used as an addition (Zahle, 2016). From a collectivist perspective, social phenomena can be seen as, for example, organizations, social processes, culture and tradition, norms and rules, social structures and so on. The methodological individualists don't agree with this view. Their explanations are expressed in

terms of individuals and their desires, actions and beliefs. In contrast to the collectivist, they believe that some of the previously mentioned social phenomena exemplify individualist properties, as norms, rules and social roles, because they're properties of individuals (Zahle, 2016).

The second dispute is about micro-foundations. Micro-foundations are the underlying mechanisms, which explained earlier, is the causal process between the cause and effect. The individualists believe this process occurs at an individual level, and connect the two social phenomena – the cause and effect. Collectivists think that in some cases the collectivist explanations stand on their own and doesn't need these individual-level micro-foundations. The individualists disagree, and think these supplement reasons are necessary (Zahle, 2016). The collectivists argue that even if the mechanistic model is correct, the micro-foundations are social-level mechanisms, rather than the individual-level mechanisms, so that even if the model is correct it cannot support individualism (T. M. Larsen, personal communication, September 2019).

4.2 Claims

Turner and Perrow have quite different theories when it comes to how accidents occur. Turner believes that sloppy management is the main reason why such accidents occur, while Perrow believe that accidents are inevitable in tightly coupled, complex systems, like the TMI-accident (Hopkins, 2001, p. 65). But, even though their theories are opposites, they are also motivated by the same desire – to prevent the front-line operators of getting the blame. Their view on accidents can therefore be said to be collectivist, by shifting the blame away from individuals.

Both the probabilistic and counterfactual claims, as well as the mechanism identified, are a part of Turner's explanation, and can be interpreted as collectivist claims. The probabilistic claim, for example, states that our technological systems may lead to the accidents occurring. Both the technological systems and accidents can be interpreted as social phenomenon, from a collectivist point of view, and therefore the claim can be seen as collectivist. The same goes for both the counterfactual claim and the mechanism identified. What might serve as micro-foundations can for example start with sloppy management, as mentioned. Sloppy management may lead to normalization of deviance, which may lead to cultures of denial, which again may lead to groupthink and so on (Turner, in Hopkins, 2001, p. 66). All this may

have led to the sloppy maintenance work, that started the five step-process that led to the accident.

Micro-foundations are certainly explanatory useful, whether or not you look at it from the individualist or collectivist point of view, and can, in many situation explain the same phenomena, seen from different perspectives. If you want to explain why an accident occurred and look at the sequence of micro-foundation, it wouldn't matter if it was explained in the individualist way: "development of negative attitude among the employees", or the collectivist way: "weakening of moral norms", as long as it's possible to trace the steps that led to the accident. In some cases, the collectivist argument can stand on its own, but only if there is causation without mechanisms. In general, micro-foundations will only contribute to a more comprehensive picture of the situation at hand.

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