Information and biomarkers of disease

Traditional thinking about causality focused on simple examples from the fundamental sciences. But increasingly current philosophers of science seek to understand causality in the full complexity of sciences such as the life sciences. This paper seeks to go even further to examine causality in cutting-edge science, where a view cannot be rationally reconstructed after the fact, as the research is still in progress. The challenge is to find an approach to causality that can embrace the full complexity of research underway and illuminate causal thinking therein.

Current research in molecular epidemiology uses biomarkers to understand the different phases of disease from exposure, to early clinical changes, to development of disease. The hope of projects such as the current FP7 project 'Exposomics' is to get a better understanding of the causal impact of a number of pollutants and chemicals on several diseases, including cancer and allergies. In a recent paper Russo and Williamson (2011) addressed the question of what evidential elements enter the conceptualisation and modelling stages of this type of biomarkers research, analysing the modelling strategy of the FP7 pilot project 'Envirogenomarkers'. In another paper Illari (2011) investigated the notion of causal production, arguing that understanding causal production is important to explain certain crucial causal inferential practices.

This paper follows up this previous work, investigating the nature of the causal link in Exposomics. First, the methods and particular inferential challenges of the Exposomics project are drawn out and explained:

- We know a lot about the system, but a lot is still unknown.
- We seek many small causes, with small effects, and large interaction effects.
- We expect widely different factors to be causes, including e.g. social and chemical factors
- Use of new omics technologies allows a comprehensive approach, but generates vast amounts of data.
- Scientists seek biomarkers of the process of evolution of the disease.
- Their meeting-in-the-middle methodology aims to match these up, to come to understand how environmental exposure is linked to the disease.

In sum, Exposomics is looking for tiny difficult-to-find causal links in the middle of a mess! This is an excellent test case for thinking about causal production, as it is a far more complex case than those usually considered.

Second, traditional metaphysical accounts (physical processes, mechanisms, powers and dispositions) are considered and it will be explained why they are all unable to provide a sensible account of the nature of the causal link as it is sought in Exposomics. One problem is that these causal metaphysics are 'tailor-made' for some specific scientific contexts (e.g., physics); another problem is that they still don't specify what does the linking (e.g., mechanisms).

Third, it will be argued that an informational account of causality can provide a causal metaphysics that works across different scientific domains, meeting two key concerns of traditional accounts of causal production – seeking what causality really is, and what the sciences say causality is – and also meeting the needs of the new kind of case that Exposomics presents.