Causation in Educational Research

Keith Morrison
Calls to understand ‘what works’ in education are being made the world over. We need to know not only ‘what works’ but under what conditions, how and why. Causation is central to this. Researchers, educationists, readers and users of research need to know the effects of causes and the causes of effects. This strongly practical book helps researchers and readers of research understand, plan and investigate causation in education. It guides readers through statistical matters, explaining them clearly and simply in words as well as numbers, and shows them how to investigate qualitative causal research in education.

After introducing deterministic and probabilistic causation, the book shows how these can be researched in different ways. It explains:

- how to determine causes from effects and how to link theory and practice in causal research
- how to plan and conduct causal research in education
- how to analyze, present and interpret causal data and the limits of causal understanding.

Containing worked examples from both qualitative and quantitative research, *Causation in Educational Research* provides a manual for practice, underpinned by a rigorous analysis of key issues from philosophy, sociology and psychology. It will appeal to new and established researchers, readers of educational research, social science students and academics.

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Causation in Educational Research

Keith Morrison
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Preface

This book addresses causation for educational researchers. Calls for understanding ‘what works’ in education are being made the world over. We need to know not only ‘what works’ but also for whom, under what conditions, how and why, on what criteria, why they work in the way that they do, and why some interventions do not work. This places causation at centre stage. If educational practice is to advance then we need to know ‘what causes what’, what are the effects of causes, and what are the causes of effects. Why do things happen as they do?

The chapters here introduce and work with the fascinating debate on causation that has been running for hundreds of years. The study of causation is not straightforward. Causation is elusive; indeed, the further one goes into it, the more elusive it becomes. A causal explanation slips through your fingers just when you think you have found it. Simplistic ideas of ‘what causes what’ must be abandoned, and this is an important message that must be sounded loud and long to policy makers and researchers. John Locke’s simple statement that ‘a cause is that which makes any other thing, either simple idea, substance, or mode, begin to be; and an effect is that which had its beginning from some other thing’ (Locke, 1997: 293) disguises the immense complexity of causation.

This book provides an introduction to causation, sets out key debates, and, above all, seeks to raise practical and theoretical matters, problems and their solutions in understanding causation. It is strongly practical in intent. If it makes researchers cautious of having any sense of certainty at all about causation, then this small volume will have done its work. We strive to understand causes and effects, but the task is not straightforward. At best we can make inferences and suggestions about causation, but that is all. We do not have the perfect knowledge required for causation to be established. This applies to those reading, using and doing research.

Writing this book has made me very sceptical of ever knowing ‘what causes what’, but it has made me want to try harder to find out, rather than to give up. Instead of the sometimes banal certainties of politicians, the careful researcher should have a large helping of modesty and humility in claiming that she or he might know the effects of causes or the causes of effects, and why things do or do not happen in the way that they do. In that spirit of modesty I hope that this book offers practical advice to researchers and those seeking to understand some limits of educational research and what can be said from it.

Keith Morrison

Macau
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Chapter 1

The world of cause and effect

The human mind is a wonderful analogue processor. It is the most sophisticated learning processor that we know. And it learns by telling stories for itself, stories of how things are, how they came to be, what is really happening, what will happen next, and why – in short, by thinking causally, filtering out the causally relevant from the causally irrelevant. Parents will know both the joy and the frustration of that period of their child’s life when he or she endlessly asks ‘why?’.

At the heart of learning and development lies causation: as Hume remarks in his work *An Inquiry Concerning Human Understanding*: 'on this are founded all our reasonings concerning matter of fact or existence' (Hume 1955: 87). Whether or not the world itself develops and emerges through cause and effect is largely immaterial; in order to avoid circularity, this book assumes that we think and we learn in part through cause and effect. Causation is both an ontological and an epistemological matter. This is unremarkable. However, how this happens is truly marvellous, for, as this book will argue, it involves a sophisticated process of evaluation and filtering, weighing up competing causal influences and judging exactly what each shows or promises. Whether we simply impose our way of thinking – in terms of cause and effect – on unrelated objects and events in order to understand them for ourselves, regardless of the fact that such cause and effect may or may not exist ‘out there’ in the objective world – i.e. that cause and effect is a theoretical construct used heuristically for humans to understand their world – is debatable. *Pace* Wittgenstein, the limits of our ways of thinking may define the limits of our world. The world may be disordered, unrelated and, in terms of cause and effect, insubstantial, but it’s nearly all we have; it’s all we can do in order to understand it.

Are we to believe Russell (1913: 1), who wrote that ‘the law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm’, or Pearson (1892), who considered causation to be a mere ‘fetish’ that should be overtaken by measures of correlation, or Pinker (2007: 209), who reports some philosophers as saying that causation is as shoddy as the material used in Boston tunnels and should be kissed goodbye, or Gorard (2001), who writes that ‘our notion of cause is little more than a superstition’? I think not. Maybe causation has little mileage for philosophers, but for social scientists it is a fundamental way of understanding our world, and we have to engage it. Indeed Pinker (2007: 219–20) shows how causation is deeply entrenched in our everyday language, in such phrases as causing, preventing, moving in spite of a hindrance, and keeping still despite being pushed.
There are several reasons why understanding and using causation are important (e.g. Lewis 1993; Salmon 1998: 3–10). For example, causation:

- helps us to explain events;
- helps us to get to the heart of a situation;
- helps us to understand why and how things happen;
- helps us to control our lives;
- helps us to manipulate our environment;
- helps us to predict events and outcomes;
- helps us to evaluate proposals and policies;
- helps us to establish ‘what works’;
- helps us to plan for improvements;
- can inform policy making;
- helps us to build knowledge cumulatively over time;
- helps us to control events to some extent;
- helps us to attribute responsibility and liability;
- is the way we think.

Understanding and using causation may not be straightforward. Indeed Glymour (1997: 202) argues that there is no settled definition of causation, but that it includes ‘something subjunctive’. Causation is a multi-dimensional and contested phenomenon. Humeans would argue that temporality is a marker of causation: one event has to precede or proceed from another in time for causation to obtain. Hume provides a double definition of causation (see his work A Treatise of Human Nature; Hume 2000: 1.3.14: 35):

An object precedent and contiguous to another, and where all the objects resembling the former are plac’d in a like relation of priority and contiguity to those objects, that resemble the latter.

An object precedent and contiguous to another, and so united with it in the imagination, that the idea of the one determines the mind to form the idea of the other, and the impression of the one to form a more lively idea of the other.

He adds to this in his Inquiry:

An object followed by another, and where all the objects similar to the first are followed by objects similar to the second. Or, in other words, where, if the first object had not been, the second had never existed.

(Hume 1955: 87)

The Humean model of priority and contiguity is represented in Figure 1.1. Note that the boxes of cause and effect are joined (the ‘contiguity’ requirement) and touch each other in time; there is no gap between the boxes and the arrow. Further, the cause only ever precedes the effect (the ‘priority’ requirement).

These are starting points only – indeed, they conceal more that they reveal – and this chapter will open up the definitions to greater scrutiny. Though Hume is concerned with regularities, other views also have to do with inferences and probabilities, and this opens the door to a range of issues in considering causation.
A fundamental tenet from Hume’s disarmingly simple yet profound analysis is that causation cannot be deduced by logic nor, indeed, can it be directly observed in experience (see also Fisher 1951; Holland 2004). Rather, it can only be inferred from the cumulative and repeated experience of one event following another (his ‘constant conjunction’ principle, in which the individual learns that if one event is followed by another repeatedly then it can be inferred that there is a probability that the two may be connected). This is questioned by Ducasse (1993), who argues that recurrence is not a necessary requirement of causation, that it is irrelevant whether a cause-and-effect event happens more than once, and that it only becomes relevant if one wishes to establish a causal law (Hume’s ‘regularity of succession’). Indeed Holland (1986: 950) suggests that Hume’s analysis misses the effect that other contiguous causes may have on an effect.

Our knowledge of causation is inductive and the uncertainty and unpredictability of induction inhere in it. As a consequence, knowledge of causation is provisional, conjectural and refutable. It is learned from our memory – individual or collective – as well as perhaps being deduced from logic or observation (see also Salmon 1998: 15). Indeed, so strong is the inferential nature of causation that we can, at best, think in terms of probabilistic causation rather than laws of causation. This is a major issue that underpins much of this book.

We have to step back and ask ‘What actually is a cause?’ and ‘What actually is an effect?’: an event, a single action, a process, a linkage of events, a reason, a motive? One feature of causation is its attempt to link two independent, in principle unrelated events. ‘Minimal independence’ (Sosa and Tooley 1993: 7) is a fundamental requisite of causation, or, as Hume remarks, every object has to be considered ‘in itself’, without reference to the other, and ‘all events seem entirely loose and separate. One event follows another, but we never can observe any tie between them. They seem conjoined, but never connected’ (Hume 1995: 85). Does X cause Y, when X and Y are independent entities? Does small class teaching improve student performance? Does extra homework improve student motivation? The relationship is contingent, not analytic, i.e. the former, in itself, does not entail the latter, and vice versa; they are, in origin, unrelated. Indeed, in rehearsing the argument that the cause must be logically distinct from its effect, Davidson (2001: 13) argues that, if this is true, then it is to question whether reasons can actually be causes, since the reason for an action is not logically distinct from that action (see also Von Wright 1993).

One of the significant challenges to educationists and policy makers is to see ‘what works’. Unfortunately it is a commonly heard complaint that many educational policies are introduced by political will rather than on the basis of evidence of whether they will actually bring about improvements. The move to evidence-based education has to be clear what constitutes evidence and what that evidence is actually telling us (Eisenhart 2005). In the world of medicine, a new drug might take ten years to develop, to undergo clinical trials, to meet the standards required by the appropriate
authorities, and even then only between 1:2,000 and 1:10,000 drugs that have been tested are actually approved for human use. Now look at the world of education: policies and initiatives are introduced on the most slender of evidence, and a signal feature of many educational initiatives and interventions is their lack of a rigorous evidence base. There is an urgent need to understand causation in order to understand what works, for whom and under what conditions; what interventions are required; and what processes occur and with what effects. Understanding causation is vital here.

There have been several recent moves to ensure that educational policy making is informed by evidence rather than political will. For example, the Social, Psychological, Educational and Criminological Controlled Trials Register (SPECTR) has been established, with over 10,000 references (Milwain 1998; Milwain et al. 1999; Davies 1999; Evans et al. 2000), evidence is appearing in the literature (e.g. Davies 1999; Oakley 2000, Davies et al. 2000; Evans et al. 2000; Levačič and Glatter 2000), and an Evidence-Based Education Network has been established in the UK (http://www.cem.dur.ac.uk). The University of London’s Institute of Education has established its ‘EPPI-centre’: the Evidence for Policy and Practice Information and Co-ordinating Centre (http://eppi.ioe.ac.uk/EPPIWeb/home.aspx), and it has already published very many research syntheses (e.g. Harlen 2004a; 2004b). The Campbell Collaboration (http://campbellcollaboration.org) and the What Works Clearinghouse (http://ies.ed.gov/ncee/wwc/) produce an evidence base for decision making. There is a groundswell of opinion to suggest the need for evidence to inform policy making (Davis 1995; Cohen et al. 2000: 394; Levačič and Glatter 2000; Ayres 2008). We should know whether something works, and why, before we put it into policy and practice.

There is a need to bring together the worlds of research, practice and theory. Goldthorpe (2007a: 8) berates social scientists for their inability to have developed laws and to have linked research with the development of cumulative theory, as has been done in the hard sciences. This book seeks to address this matter in part. It introduces and opens up an understanding of causation. It deliberately avoids the formulaic presentations that one reads in philosophical works and works on logic. That is not to demean these; on the contrary, they are essential in clarifying and applying concepts of causation. However, it places these into words, so that the novice reader can grasp their significance for the approach adopted here.

Causation – cause and effect – is no simple matter. If only it were, but it is not! This book indicates why causation is far from being as straightforward as policy makers might have us believe. It is complex, convoluted, multi-faceted and often opaque. What starts out as being a simple exercise – finding the effects of causes and finding the causes of effects – is often the optimism of ignorance. One can soon become stuck in a quagmire of uncertainty, multiplicity of considerations, and unsureness of the relations between causes and effects. The intention of this book is to indicate what some of these issues might be and how educational researchers, theorists and practitioners can address them. The book seeks to be practical, as much educational research is a practical matter. In this enterprise one important point is to understand the nature of causation; another is to examine difficulties in reaching certainty about causation; another is to ensure that all the relevant causal factors are introduced into an explanation of causation;
and yet another is to provide concrete advice to researchers to enable them to research causation and cause and effect, and to utilize their findings to inform decision making.

A final introductory note: readers will notice that the term ‘causation’ has been used, rather than, for example, ‘causality’. This is deliberate; whilst both terms concern the relation of cause and effect, additionally ‘causation’ is an action term, denoting the act of causing or producing an effect. It expresses intention (Salmon 1998: 7). This is close to one express purpose of this book, which is to enable researchers to act in understanding and researching cause and effect.

### Implications for researchers:

- Consider whether the research is seeking to establish causation, and, if so, why.
- Consider what evidence is required to demonstrate causation.
- Consider whether repeating the research is necessary in order to establish causation.
- Recognize that causation is never 100 per cent certain; it is conditional.
- Decide what constitutes a cause and what constitutes the effect.
- Decide what constitutes evidence of the cause and evidence of the effect.
- Decide the kind of research and the methodology of research that is necessary if causation is to be investigated.
- Decide whether you are investigating the cause of an effect, the effect of a cause, or both.
- Causation in the human sciences may be probabilistic rather than deterministic.
Chapter 2

Tools for understanding causation

This chapter traces in some key concepts in approaching and understanding causation, and, in doing so, indicates some of the historical antecedents of the discussion. As the chapter unfolds, it indicates an ever-widening scope of the concept of causation, begging naïve attempts to oversimplify it. At each stage of the discussion implications are drawn for educational researchers.

There are different kinds of causation, and the examples in this book instance deterministic causation and probabilistic causation. In deterministic causation, if such-and-such a cause obtains, then such-and-such an effect certainly follows. In probabilistic causation, if such-and-such a cause obtains, then (arguably, as discussed later) it raises the likelihood of such-and-such an effect, but does not guarantee it. Causation involves a change or transition (Belnap 2002: 4; Müller 2005). The examples in the book are vehicles for raising debates and concepts in understanding causation in educational research.

A worked example: the fight in the school playground

The problem of understanding and knowing what to include in understanding causation is not straightforward. Consider the following example.

Two teenage boys – David and John – are fighting in the school yard. The teacher separates them and then speaks to them both. David says that he had started the fight because John had insulted him, that he had returned an equally offensive insult, and the fight had ensued. Does the story remain there? Was the cause of the fight a couple of insults idly traded? Well, perhaps so or perhaps not. Maybe David and John had volatile personalities, such that any spark would cause a massive overreaction – i.e. maybe it was the personalities that caused the fight. Or say that David and John had had an argument a few days previously, which had ended by David saying that, if John ever spoke to him again, he would hit him. Does that constitute a cause of the present fight?

And why did David make this remark? Maybe there was a history of trouble between the two families that had pre-dated the particular events in question (the previous argument and the present fight). Maybe the combination of the family feuding and the volatile personalities involved, or maybe the family problems, mediated through the personalities involved, created an easily combustible mixture. Or maybe the fight was the culmination of an increasingly acrimonious feuding between the two boys, such that the final hurling of insults was the straw that broke the camel’s back.

And why was there a history of trouble between the two families? Maybe both families were living in the same ‘sink’ estate of ghetto housing, in which ‘problem families’
were placed together by the local authority, perhaps because of a history of non-payment of housing rent, petty criminality, aggressive behaviour to authority figures and other members of the community, long-term unemployment and disrespect for other citizens. And why were such 'problem families' placed together in a single ghetto? The local authority, wishing not to have several neighbourhoods disturbed or vandalized, in order to restrict the effect of violent and disruptive families on law-abiding citizens who simply wanted to go about their business, and in order to 'contain' the potential criminal elements within the community and, hence, to be able to police the community more efficiently, had decided to house such disruptive elements together in a single estate, to contain the problem. Why had the local authority taken this decision?

On the one hand, in community and societal terms it was attempting to keep law and order, to restrict societal breakdown and to promote civilized behaviour. On the other hand, the local authority was poor, and it was attempting to ensure the greatest return on the money spent on the community and its policing. Why was the local authority so strapped for cash? Maybe it was because it had had to put money into providing additional incentives for teachers to work in its schools. And why was it so difficult to recruit teachers? Maybe it was because the media had orchestrated a high-profile campaign of negative publicity against government policy that, so the press had claimed, brought teachers massive pressure, responsibility and workload without due remuneration, respect and power, turning them into low-level technical operatives with little control over their working lives yet held accountable for matters over which they had no control and with which they did not agree – they had become the 'whipping boys' of a society going out of control.

So, what was the cause of the fight: the insult; the personalities; the argument; the aggressive inter-family feuding behaviour; the placing together of 'problem' families; the local authority's housing policy; the desire to promote and preserve decent community behaviour in the populace; the need to restrict and contain the outbreaks of unacceptable behaviour; the local authority's lack of money; the problem of balancing competing priorities; the government's education policy; the media? How far back in time does one have to go to establish causation (the temporal dimension: Hume's element of 'priority' as a fundamental feature of causation – the cause must precede the event) and over how many contexts (e.g. the spatial or environmental dimension – however defined) – how far out – does one have to go to establish causation? Indeed, how far in does one have to go to establish causation? Do more immediate conditions and causes override – screen off – earlier or more remote conditions (Salmon 1998: 43)? Is it necessary to go to the causae causantes (the originating causes) in order to understand the present situation (Belnap 2002; Müller 2005)? Discovering causation can recede ad infinitum. The notion of causation here can be represented diagrammatically as in Figure 2.1.

Understanding causation is problematical, as causes, causal processes and mechanisms are not easily observable, in fact may not be directly observable at all, which means that they are difficult, if not impossible, to ascertain fully or to measure at all (Holland 2004). The discovery of causes, causal processes and causal mechanisms is an exacting and tentative affair.

**Cause and effect: the problem of inclusion**

What are included and what excluded in the causes of an effect? If one includes everything, then establishing causation becomes unmanageable; if one excludes factors, then
one is misrepresenting the nature of the causation through oversimplification and selectivity, though manageability becomes more straightforward. As Mill (2006: 332) remarks, to understand causation we have to include all the antecedent factors, i.e. the environment and all the conditions. A cause, he observes, ‘is the sum total of the conditions positive and negative taken together … which being realized, the consequent invariably follows’.

**Implications for researchers:**
- Be prepared to look back in time and across a variety of contexts and conditions in establishing causation.
- Ensure inclusion of the relevant causes.
- Try to keep the number of causes to a manageable number, without omitting important ones.

Mill’s view is not without its difficulties, however. Firstly, he is discussing regularity, a deterministic rather than a probabilistic view of causation. Secondly, Ducasse (1993) argues that, if the causal relation involves (a) the environment of an object, (b) some change in that environment, and (c) the resulting change in that environment, then it is impossible to include some change in the environment as part of a cause, because the cause itself consists of a change in that environment. If the cause of an effect involves a change in the environment, then it is impossible to use the environment as part of the cause without circularity.

Thirdly, Mill’s view that all the antecedent conditions constitute causes, even if true, might become unwieldy in practice. One attempt to reduce this to manageable proportions is by identifying strong and weak causes, though it is not always clear which are strong and which are weak and how one measures strength – or, indeed, if ‘strength’ is important. Another attempt is made in the notion of necessary and sufficient conditions (e.g. Mackie 1993), and these are discussed below. Davidson (2001: 117) suggests that the more fully we can describe the cause, the greater is the possibility of demonstrating that it was sufficient to produce the effect; in addition, the more fully we can describe the effect, not only is there a greater possibility of demonstrating that the cause was necessary, but also the possibility of demonstrating that it was sufficient is reduced.
Implications for researchers:

- Identify the necessary and sufficient conditions and causes in the situation.
- Provide as full a set of details of conditions as possible.

What exactly is the cause? Can a macro-cause (e.g. the wider society) impact on the micro-situation (e.g. Durkheim’s ‘social facts’ – ‘any way of acting, whether fixed or not, capable of exerting over the individual an external constraint or which is general over the whole of a given society whilst having an existence of its own, independent of its individual manifestations’ (1982: 59), where, in order to avoid reliance on psychological interpretations of social behaviour, one seeks social causes of individual behaviour)? Which are necessary and/or sufficient causes?

Further, returning to the example of the boys fighting, we have possible reasons for the fight, but are these causes? A reason might be a motive, but that may or may not be the same as a cause. This rehearses the ambiguity of the word ‘why’ as in ‘Why were the boys fighting?’; it may refer to causes (e.g. historical and current antecedents), to reasons and to purposes (e.g. future intentions). Intentions may not be the same as causes; as Davidson (2001: 8) remarks, a person may go to church in order to please his mother, but behind this lies yet another cause or reason (e.g. Why does he wish to please his mother?). Maybe the reason behind the intention is actually the cause. Davidson (ibid.: 264) argues against the false equation of a motive with a reason in the context of establishing causation: I may have a motive to perform a certain act, but I may actually perform it for different reasons. For example, I may wish to set additional homework for a class of students in order for them to learn more science (the motive), but the reason I actually set them homework, in the event, was because it was a school requirement. Nonetheless, a motive may be a cause.

Ryan (1970: 117) distinguishes between reasons and causes in the criteria used to evaluate them. In the case of a reason one can say that it is good or bad, or somewhere in between. In the case of a cause the notion of ‘good’ or ‘bad’ seems inappropriate: something is or is not a cause; it brings about an effect, regardless of whether it is good or bad. There is a category difference between reasons and causes. A child in school may misbehave repeatedly in order to attract the teacher’s attention; this is a cause, even though it is not a very good reason.

Implications for researchers:

- Consider whether the research is seeking to identify causes, reasons and/or motives.
- Recognize that reasons, motives and causes may be similar but also may be different.

Before we move on, it is useful to consider a little further the views of Mill (2006) in discovering evidence of causal relations. He indicates five main methods of such discovery:
Agreement: ‘If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree, is the cause (or effect) of the given phenomenon’ (Mill 2006: 390). For example, if we observe that two days in which students are absent from school are always the days on which chemistry lessons occur, we might infer that it is something about chemistry lessons that causes them to be absent, but if we observe that they are absent on other days as well then our causal inference is weakened. This is the method of correlation.

Difference: ‘If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common except one, that one occurring in the former; the circumstance in which alone the two instances differ is the effect, or the cause, or an indisputable part of the cause, of the phenomenon’ (ibid.: 391). For example, if we observe that on days when chemistry lessons occur then many students are absent, and that on days when no chemistry lessons occur they are present, then we might infer that chemistry lessons are the cause. However, there might be other reasons working here, for example, on the same days as those on which chemistry lessons occur there might also be physical education, and the lazy students decide to absent themselves on such days. In fact Mill is alluding to the experimental method in which control and experimental groups are matched on all variables except one. The isolation and control of all relevant variables, as will be discussed later, is probably unrealistic in much educational research, most of which conforms to non-experimental methodology.

Agreement and difference: ‘If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of the circumstance, the circumstance in which alone the two sets of instances differ, is the effect, or the cause, or an indispensable part of the cause, or the phenomenon’ (ibid.: 396). This combines (a) and (b). So, for example, we could observe the attendance on chemistry days and on non-chemistry days as in Table 2.1.

Here we have a sample of chemistry lesson days (to see if attendance is low on such days) and non-chemistry lesson days (to see if attendance differs from chemistry lesson days in having high attendance). The research has four hypotheses:

(i) Low attendance occurs on chemistry lesson days;
(ii) High attendance occurs on non-chemistry lesson days;
(iii) There may be some chemistry days with high attendance;
(iv) There may be some non-chemistry days with low attendance.
What we have here is a statement of initial conditions (discussed in Chapters 2 and 3 here). We can see from the table that hypotheses (i) and (ii) are supported. The example is important, for it directs our attention to the need to make comparisons amongst different conditions (cf. Hage and Meeker 1988: 47); if one were to examine only chemistry lesson days or only non-chemistry lesson days, then we would have an incomplete test. Some of the hypotheses predict presence and some predict absence, so both conditions have to be included in the test.

(d) **Residue**: 'Subduct [remove] from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents' (Mill 2006: 398). Whilst (a) to (c) concerned the relationship between two variables (cause and effect), here Mill is referring to the issue of the possible effects of a third introduced variable, the control variable (discussed in Chapter 3 here). For example, we may suppose that the chemistry lesson deters students from attending school, but there may be a third variable, a number of sporting events on the television on the same day each week, that may be causing the effect.

(e) **Concomitant variation**: ‘Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon or is connected with it through some fact of causation’ (ibid.: 401). Mill is referring to correlational techniques here, those with large coefficients of correlation demonstrating greater correlation than those with lower correlation coefficients. Of course, correlation is not the same as causation, and this may be a problem with Mill’s suggestion, except that constant conjunction in time (one event preceding another with great regularity) may infer causation (according to Hume). The strength of a correlation may or may not indicate its causal relation.

One can see resonances between Mill and his predecessor Hume, in that both are relying on induction to demonstrate causation.

### Causes and conditions

The question of what to include and exclude in causation is problematic; there are many contributing causes, and the task is to identify which causes are important or relevant, and how to decide how to decide. Take the example of the case of somebody falling and breaking a hip whilst out walking. Maybe the fall was caused by a loss of equilibrium that, itself, was the result of a head injury years before. Maybe the road was icy and the earlier loss of equilibrium from the head injury played a part on this subsequent occasion. Maybe the person was wearing the wrong kind of shoes (e.g. with slippery soles); maybe there was no handrail to hold alongside the footpath; maybe there was a sudden gust of wind; maybe the person had a genetic disorder and was overweight, such that a simple overbalancing had a major effect; maybe the person was walking carelessly. Here the causes are not only several but are both genetic and environmental, and are not simultaneous – some are delayed from an earlier period and some are contemporary.

What we also see in this instance is an example of how the cause triggers the effect under a specific set of circumstances or conditions. As Mellor (1995: 69–70) suggests,