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CHAPTER 6

CAUSAL ANALYSIS, SYSTEMS ANALYSIS, AND MULTILEVEL ANALYSIS: PHILOSOPHY AND EPISTEMOLOGY

The previous chapters, written by specialists in different social sciences, have examined multilevel analysis as a new methodology that can encompass multiple levels of aggregation, with a view to answering novel questions raised in their respective fields. In education, for example, the multilevel approach can analyse an individual's responses to tests as a function not only of individual characteristics, but at the same time of the characteristics of the student's class, school, neighbourhood, etc. The joint analysis of these aggregation levels provides a far more accurate view of the effects of the characteristics than a study conducted at a single level. The contributors to this volume have therefore adopted an essentially methodological approach to show how multilevel analysis can overcome the difficulties encountered when working at a single aggregation level, whether individual or aggregated. By observing some of the gaps and inconsistencies between the results obtained using other analytical methods, the authors have shown the value of the multilevel approach, which solves most of these problems and offers an overall view of the characteristics operating at each aggregation level.

But, while the examination of new methods is essential to understanding the improvements they bring to the social sciences, it should not make us forget that methodology is not a branch independent from epistemology. Epistemology is the equivalent of Philosophy of Science. The last term suggests that the sciences are the focus of the investigation, while epistemology is concerned with the nature of knowledge in general. In fact, philosophy of science is, more often than not, concerned – as is epistemology – with scientific knowledge in general, discussing for instance the nature of scientific theories, the ways of their validation, the role of experience in scientific investigation, the meaning of probability, etc. Many works in the philosophy of science refer to the sciences only in order to illustrate by examples the ideas put forward. Other philosophers of science try to give a new insight by a thorough examination of the scientific practices. Following this course, Robert Franck emphasises the importance of methodology. According to him, a close examination of the methods in use allows us to bring nearer to each other the research practices and the philosophical concepts. The advantage for philosophy is obvious. But as long as the social sciences are feeling their way, a deeper assessment of the significance and of the limitations of the methods in use might also help to improve the research practices. And the philosophical concepts are of great help for this assessment. Robert Franck invites us to take that step, with an in depth examination of the concepts of "cause" and of *"system". The goal is to show the advances that the multilevel analysis allows in the social sciences, and to find stronger underpinnings for it.*

First, the introduction of multilevel models gives a totally new twist to the still lively debate over the relations between society and the individual, or between holism and methodological individualism in the social sciences. This dualist approach, which sets the whole against the parts, effectively raises the more fundamental issue of the priority of one over the other. Holism—defended, for example, by Durkheim (1895)—gives precedence to society's action on human behaviour, and treats social facts as external to individual conscience. By contrast, methodological individualism—defended by Boudon (1988), among others—aims to explain the same facts by reconstructing the motives of the individuals concerned and presenting the facts as the result of the aggregation of individual behaviours dictated by those motives. But once we adopt the hierarchical or multilevel approach—where the opposition between the whole and the part is abolished, but where an entity we regard as a whole can become a part of a more aggregated level and vice versa—it no longer makes sense to choose between holism and individualism, and the opposition vanishes (Franck, 1995). On the other hand, we now need to explore the connections between levels and study the mechanisms that will enable us to integrate the levels. This takes us into a far more theoretical study.

The reason is that we are confronted with the theoretical issue of the organisation of the levels and the existence of an underlying functional structure, which would help us better understand how human societies live and evolve. For example, the functional structure of a migratory system is not found in the linkage between (1) individuals' probability of migrating and (2) their own characteristics and those of the regions they inhabit; rather, the structure is to be found in the economic functions, family functions, spatial-distribution functions, and other functions implied by migration. The approach suggested by Robert Franck will thus use multilevel analysis differently from earlier contributions, with the aim of going further and identifying the functional structure underlying behaviours. Instead of seeking only to identify the individual and aggregated characteristics that can influence a given behaviour, multilevel analysis seeks to identify and understand the functions that the aggregation levels will perform in the multilevel system considered.

In order to explore the nature of the connections between levels, Robert Franck carries out an examination of several types of causal determination and of their impact on multilevel analysis. Then, he clarifies the nature of levels, by the aid of the philosophical concept of hylemorphism. This concept allows us to understand the emergence of systems, at a higher level, from factors acting reciprocally at the lower level. Under these conditions multilevel analysis may be enlarged to deal with the influences of factors over the emerging system, and to the influence of the emerging system over the same factors, leading to new procedures for the analysis of system functions.

An advance of this kind in the social sciences is, for the moment, a theoretical possibility more than a reality. We have no choice but to recognise that the identification of a functional structure that objectivates lived human experience, and the transition from that structure to an active recapture of lived experience, are still far from totally effective. The social sciences have not yet "managed to define the categories that allow, even in a temporarily satisfactory manner, the objectivation of *human experience" (Granger, 1988). But we shall see that Robert Franck raises new possibilities here for moving closer to that functional structure, by making creative use of the paths opened up by multilevel analysis. These possibilities attest to the social sciences' ever greater proficiency in their approach to human reality, and augur well for objectivation in the future*

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1. INTRODUCTION. OBJECT OF THIS CHAPTER

Many efforts are made in the social sciences to establish causal relationships between social phenomena, and statistical analysis is the privileged means of establishing such relationships. Multilevel analysis comes under this general heading for social science research. It offers the advantage of being able to take collective as well as individual variables into account, and of being able to hierarchize these variables with respect to two or more levels. In this way multilevel analysis refines the statistical study of causal relations which generate observed phenomena, and improves our understanding of social life.

Are the determinative relationships which we manage to establish in social science between two or more phenomena always of a causal nature? This is a widely held opinion. To be more precise, researchers hesitate to speak of *causes*, preferring to refer to *factors*, a term which seems less burdened with philosophical connotations. They also know that a relationship of functional dependence is far from always indicating a determinative relationship. But in general they think that when there is a relation of determination between social phenomena, that determination can only be causal. However, Mario Bunge (1979) showed as early as 1959 in his famous work on causality that physical and biological sciences resort to various kinds of non-causal determination in order to explain natural phenomena. In the field of social phenomena, determinations are not limited to causal relationships either. Would greater attention to the nature of non-causal determinations at work between social phenomena augment the potential of multilevel analysis? That's what I will attempt to show in the second part of this chapter. The examination of non-causal determinative relationships should also allow us to understand the nature of relationships between levels.

Aside from the fact that there are different kinds of non-causal determination, there are also different kinds of causal determinations. For example, alongside the type expressed by the phrase "same cause, same effect" there are *interactions* in the sense given this term by Raymond Boudon (1967), which Paul Lazarsfeld previously described by multivariate analysis. I will examine a number of forms of causal determination from which multilevel analysis can benefit, and I will point out some of their theoretical implications. The examination of these different kinds of causal determination will be the object of the first part of this chapter.

The world is varied and changeable. This is as true of nature as of society. How then can we arrive at lasting and generalisable knowledge? This question gave rise to European philosophy (see Parmenides, Heraclitus, Plato, Aristotle etc.). It concerns the natural sciences as much as the social. However, our awareness of socio-cultural differences has given the question a particular shape in social science. We see that social life is diverse and variable, differing from one place to another and from one period in history to another - and within a single time and place, social groups differ. Must we resign ourselves to admitting, as we see our analyses made more and more sensitive through multilevel analysis, that in the social realm there is no knowledge which is not particular? The examination of different possible forms of causal determination, in the first part of this chapter, will permit us to find out how necessary and relatively durable relationships can be established between social phenomena.

Ana Diez Roux describes, in this book, the challenges and limitations of multilevel analysis, and some possible alternative and complementary approaches to it. I will return presently to the methodological difficulties she has identified, and attempt to make a contribution to solving them. This chapter thus takes up where her chapter leaves off. I will begin by responding to her invitation to doubt the notion that effects are always separable ("dissection of risk"): I will present a kind of inventory (as mentioned above) of some other forms of causal determination which should be useful in epidemiology, and indeed in other disciplines. Among the points of difficulty raised by Diez Roux, one seems to me crucial for the future of multilevel analysis. Koopman (1996, p. 630, cited by Diez Roux) sums it up this way: "(...) epidemiology is in transition from a science that identifies risk factors for disease to one that analyses the systems that generate patterns of disease in populations." What must we do, to go from identification of factors to analysis of systems? Or better, how can we combine, in analysis, factors and the systems they belong to? Can multilevel analysis be open to the analysis of social systems? In other words, can multilevel analysis accommodate the structure of groups, of contexts, and of levels in its operation? The problem of combining factors and systems is not specific to epidemiology, but is shared by all social sciences (M. Loriaux, 1994). I will try to show how a system of factors determines, in a non-causal way, the effects these factors can have, and how, inversely, factors generate and determine non-causally the structure of the system they belong to. That will help us to grasp the specific nature of relationships between levels (must we, following Susser and Susser (1994), think of these as being like Chinese boxes?), and allow us to consider the extension of multilevel analysis as applying to determinations of a new kind.

2. THE CAUSAL PRINCIPLE

2.1. The advantages of the principle "same cause, same effect".

Tradition connects the relation of cause and effect to the principle: "the same cause produces the same effect". According to this principle, one cause can have only one effect, and an effect can have only one cause. For example, Emile Durkheim noted that if there were different causes of suicide, there must also be different kinds of suicide, and that every kind of suicide had to have a different cause. But in the last fifty years the principle, “the same cause produces the same effect”, has been fighting in retreat, while notions of multiple causation have gained ground. I will speak about multiple causation in a moment, but first I would like to draw attention to the advantages of the principle of “same cause, same effect” at the methodological level. These advantages are quite large. We forego them if we abandon the principle, if we for example admit (as is done in multilevel analysis) that a phenomenon is the result of a combination of the influence of several causes operating at different levels.

First advantage: if it is true that an effect can have only one cause, then when the cause is known it is unnecessary to ask whether in other places or at other times the same effect can have a different cause. Thus a causal explanation can be generalised. Every time the effect is observed, we can identify the cause without having to search for it all over again. The cause is known once and for all. Cavils about socio-cultural differences which otherwise would forbid generalisations of causal explanations which may be put forward are overcome if we stick to the principle of “same cause, same effect”. But if we give up the principle, how can we guarantee that our analysis is valid outside the time and place of our investigation?

Second advantage: if it is true that a cause can have only a single effect, we know that the cause will never, here or elsewhere, produce any effects but those it is known to produce, whatever the context. Knowledge of the effect can be generalised. That is no longer possible when we have given up the principle, “same cause, same effect”.

Third advantage: we can be equally certain that the effect will not be produced if its cause is not present.

Fourth advantage: if the effect is present, we can be sure the cause also is, even if it has not been observed. The effect implies its cause, not by a logical implication, but because the existence of the effect supposes that it has been produced by its cause.

2.2. According to this principle, causes are necessary, but their effect is contingent.

Does the principle also mean that the existence of a cause implies the existence of its effect? In other words, when the cause is present, are we sure that its effect will follow? No. Contrary to a widely held opinion the principle “same cause, same effect” does not tell us whether a cause is always followed or accompanied by its effect. And that obviously limits the predictive power granted by the principle. The principle does let us predict that a cause will have no other effect than the one already known, and also to predict that the effect will not occur if the cause is absent. That is quite a lot. And I underline once more that as soon as we give up the principle, “same cause, same effect”, we lose any means of making that kind of prediction or forecast. But having noted that, we should recognise also that the kinds of prediction the principle allows us to make still do not tell us what is going to happen. The principle tells us that the effect cannot occur if its cause is absent, but since we don’t know if that cause will be present in the future or not, we don’t know if the effect expected will be produced or not in the future. Neither does the principle permit us to say what is not going to happen. It guarantees that if the cause in question occurs, it will produce no other effect than the one it is known to produce - but a thousand other effects may occur as a result of the action of a thousand other causes. In short, the power of prediction gained through "same cause, same effect" is not a power of predicting the future. It is the power to expect an effect, though only as a *possibility*, and only if the presence of the known cause has been observed.

Why does the principle stipulate the necessity of the cause but not that of the effect? Where does the asymmetry in the principle of causality come from? It is the result, quite simply, of the traditional ontology which is the inspiration of the principle. One assumes that a cause is capable of producing its effect by its very nature (it is not a question here of accidental effects, but of one or another effect which is specifically linked to the given cause). The cause, obviously, cannot produce any specific effects other than those which its nature permits. And these specific effects, just as obviously, cannot be produced if the nature (of the cause) which can produce them is absent. On the other hand, why should the cause imply the production of its effect? Nothing forces us to think that a cause must necessarily produce its specific effects; it can produce them or not, according to circumstances. Thomas Aquinas, for example, writes (c.1272, part I, Q. CXV, a.6): "It is not true that, given any cause whatever, the effect must follow of necessity. For some causes are so ordered to their effects, as to produce them, not of necessity, but in the majority of cases, and in the minority to fail in producing them. But that such causes fail in the minority of cases is due to some hindering cause." I repeat this citation from Bunge (1979, pp.103-104), who adds : "Leibniz had an idea of this when he said that it is necessary that everything have a *cause*, but it is contingent that every cause should produce its *effects* (...)"

If the production, by a cause, of its effect is not necessary but rather contingent, the question of determinism must be examined anew. One is not obliged to give up determinism (which states that "everything has a cause" or that "everything is determined") in order to avoid believing that the world is pre-determined, or that human beings are pre-determined to act as they do. Bunge demonstrated this convincingly (op. cit. p. 101-07). He writes: "an essential mark of causality and, indeed, of every other type of lawful determinacy, is conditionality (...) statements of causal laws assert that *if*, and only if, certain conditions are met, certain results will follow. A change in the conditions will therefore ensure a change in the results (...)." Bunge observes that many researchers have opposed causality and determinism, pleading in favour of the possibility of indeterminacy, in order to protect themselves against falling into pre-determinism. The distinction Bunge emphasises, between determinism and pre-determinism should be taken as placing causality and determinism beyond the reach of these opposing pleas, if their purpose was to guard us against pre-determinism. Causal determinations are conditional; further along we shall present another argument in favour of a separation of the question of determinism ("everything that happens has a cause") from that of pre-determinism ("a cause necessarily produces its effect").

3. MULTI CAUSAL MODELS

For half a century now social science has taken an interest in the plurality of the causes of a single event. Econometrics played a pioneer role in the modelling of a variety of factors which may contribute to the determination of a phenomenon. Diez Roux drew our attention to the limited usage of multicausal models in epidemiology.

Epidemiologists often assume that various risk factors act separately, and they attempt to differentiate their several effects. This leads them to neglect the presence of causal chains, and the effect of interference between certain factors in the etiology of diseases which occur in individuals or in populations. Diez Roux fears that calling in multilevel analysis will add only another different kind of variable, a group-level variable. She wants to see multilevel analysis in epidemiology become aware of causal interferences and non-causal determinations (in speaking of the latter she of course refers to Bunge).

I will examine possible kinds of interferences, and I will underline some of their theoretical implications, as I did above regarding the principle, “same cause, same effect”.

3.1. Disjunctive multiple causation

The emphasis on “dissecting risk” in epidemiology corresponds to that which Bunge has called *disjunctive multiple causation* (op.cit. pp.122-125). This occurs in situations in which several causes can produce a single effect, that is, any one of them is a sufficient cause of the effect, although the effect of one cause cannot be added to the effect of another cause. Each cause might produce the effect independently of each other, and thus we can believe that there is no interference between them. Still, there is one sort of interference whose consequences can be decisive in demographic forecasting, as Guillaume Wunsch has pointed out (1988, p.45). What happens when two causes which can produce the same effect separately or disjunctively do not act simultaneously? For example, heart attacks and cancer are two causes of death; if one dies of a heart attack, one can no longer die of cancer, and vice-versa. Each cause only produces the effect if the other has not acted beforehand. Disjunctive multiple causality is of course not limited to two causes. For example, there is a large number of causes of death which act separately. We see in this way that the effect of time on causal determinations is sometimes decisive.

3.2. Conjunctive multiple causation

A second type of multiple causation occurs when two or more causes together produce an effect, though each alone does not produce it. Here the interference is evident. One supposes that each of the causes which act together is a *necessary* but not a *sufficient* condition of the production of the effect (Nowak, 1975). In other words, each of the causes is unable by itself to produce the effect, but none of them can be lacking in the causal combination, or the effect will not be produced. If none of the causes are lacking, the causal combination is a *sufficient* cause of the production of the effect. *Sufficient*, but not *necessary*, however. Other causes or other causal combinations might also produce the effect. When we give up the principle, “same cause, same effect” in favour of multiple causation, no cause continues to appear *necessary* for the production of the effect. The number of possible causes of an effect appears thus unlimited in principle. This allows us - and condemns us! - to continue putting forward new causal hypotheses : however convincing the results obtained in the course of verifying or corroborating a causal hypothesis, a thousand other causes could just as well produce the same effect, at other times or under other circumstances.

Still, conjunctive multiple causation introduces us to a new kind of causal necessity. What meaning is to be given for this kind of necessity? Each cause necessary for the production of the effect is necessary *relative to* the required combination of causes. In reality, this kind of necessity is not well known in empirical social science. Any choice of hypothetical factors is hardly based on the necessity of their complementarity. Is this type of causal necessity an illusion? An examination of the "INUS condition" (Mackie 1965 and 1974) will help us answer.

3.3. INUS condition

INUS is an abbreviation for : "an Insufficient but Necessary part of a condition which is itself Unnecessary but Sufficient for the result." John L. Mackie illustrates the INUS condition in this example: a short-circuit is the cause of the fire in the house, a *non-sufficient* cause because flammable materials must also be present, yet still necessary in order for the flammable material to catch fire. The short-circuit and the flammable material together form a *sufficient* condition for a fire occurring - but while sufficient, the combination is not *necessary* because a fire could be caused in other ways. Mackie's example has the merit of throwing into relief that odd mixture of contingence and necessity which is found in all causal processes in which the effect results from the conjunction of multiple causes. But it is precisely this mixture which begs the question. Isn't the necessity referred to illusory?

Mackie has also had the merit of showing how "a unique sequence can be immediately recognised as causal". If the police chief can establish, first, that there was a short-circuit, and secondly that all other possible causes of the fire were absent, he might legitimately conclude that the short-circuit caused the fire. He does not have to support his conclusion by means of repeated observations or statistical regularities. On this point, one can understand the interest which has been shown in the INUS condition, since it appears to elude a requirement of the empiricist philosophy in the Humean tradition which was thought unavoidable, namely that causality requires regularity in the relation between cause and effect, and that the establishment of a causal relation requires us to have observed a regular connection between two events. [1] The INUS condition is, according to Marc-Wogau (Marc-Wogau K., 1962, pp. 226-227), "a necessary condition *post-factum*" which corresponds to causal explanation in history.

A match or a cigarette falling from an ashtray, or the pilot light of a gas stove might cause a fire as the short-circuit did. Thus the short-circuit is in no way a necessary condition for a fire. So why did Mackie insist that the short-circuit is a *necessary* part of the conditions for the fire? He explains that the police chief was able to eliminate all other possible causes of a fire, and that he had verified that a short-circuit had occurred. That was sufficient to establish that the short-circuit was the cause of the fire breaking out. Is that sufficient for calling this cause a necessary one? The short-circuit is a necessary cause *post-factum*, as Marc-Wogau put it. That means that without the short-circuit, the fire could not have occurred, since all other possible

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[1] John Stuart Mill (1891, Book III, ch. III, 2, 3), who had a decisive influence on empiricist philosophy, nonetheless affirmed that it is possible to establish a causal relation based on the observation of a single occurrence. One can do this, he writes, through the aid of the inductive method as established by Francis Bacon, not by settling for induction understood as enumeration.

causes were not present. The short-circuit was therefore necessary, but in a quite particular manner : it was necessary since any other cause capable of carrying out the function of setting fire to flammable material was lacking. We might say that such a necessity is... contingent! The necessity of the cause - for the production of the effect - is contingent because it depends on the presence or absence of other causes which could have fulfilled the same function (the function of setting fire to flammable material) as part of a particular combination of causes. But is it not then true that behind the necessity of the short-circuit, there is another sort of necessity hidden, the necessity of its function?

Flammable materials do not set themselves on fire. Something has to set them on fire. The necessity of the short-circuit (that which I called a contingent necessity) is based on another kind of necessity, the necessity attached to its function within the singular combination which caused the fire. The INUS condition is deduced from the necessity of its function within a particular combination of causes and from the absence of other factors which might have fulfilled that function. Mackie did not pay much attention to that kind of necessity, which is not causal but functional. And yet it is this latter sort which is - it seems to me - the basis of the INUS condition.

3.4. Two new kinds of necessity

The causal necessity brought to light by Mackie under the name of the INUS condition is not an illusion. This type of necessity is quite different from the one which went along with the principle, "same cause, same effect", which stipulated that a single effect can have only a single cause. For Mackie's necessity is *relative to* a given combination of causes. One cause can cease to be necessary, or on the contrary become necessary to the production of an effect, according to the context, that is, according to the presence or absence of individual or social characteristics of different levels. It is apparent that this type of necessity must be of interest to multilevel analysis since it shows the decisive role of a context in relation to the pertinence of a proposed causal explanation.

Underlying the Mackie's INUS condition, we found another kind of necessity : the necessity of the functions which have to be carried out in order for the effects to occur. These functions guided the police chief's investigation into the causes of the fire. What flammable materials were present in the house, and what possible sources of a spark were there? His knowledge of combinations of functions necessary for the production of the observed effect allows him to reduce drastically at the outset of the investigation the number of *possible* causes. Similarly, someone using multilevel analysis does not have to explore all the factors and levels which are imaginable. If the researcher knows which functions have to be carried out in order for the phenomenon (which he or she is trying to explain) to occur, then the combinations of factors at various levels chosen for testing will be those which *can* fulfil those functions. This second type of necessity should also interest multilevel analysis since it can guide the researcher in the choice of pertinent factors at various levels.

I am convinced that researchers in social sciences raise questions spontaneously concerning functions which must be carried out in order for a given observed effect to be produced, in the course of their proposing a causal hypothesis to explain it. But what we have just learned leads us to conduct this questioning, about functions necessary for the production of an effect, in a methodical fashion. We will reach this same conclusion at the end of the second part of this chapter, at which time we will have established the usefulness of opening up multilevel analysis to systems analysis.

In the introduction to this chapter I stated that we would seek to know whether there existed determinations which can lead to generalisations, even though all evidence indicates that social life is unstable. We will no longer seek help from the principle, "same cause, same effect". Help must come from the methodical study of combinations of functions which are necessary for the production of the observed effects. That which can be generalised over several different social contexts as concerns observations of a single effect, is the combination of functions which are necessary for the production of the effect. It is because this combination is *necessary* (and on condition that it is really necessary) for the production of the effect, that it can give rise to generalisations applicable to any situation or social context in which the effect is actually observed.[2] That is not how things stand with the combination of factors which produces the observed effect within a given context, because the same combination of functions can be carried out, in different contexts, by different combinations of factors.

In the second part of this chapter, I will show how the study of combinations of functions fits into the framework of systems analysis. We will then find out that a combination of functions has a real power to determine phenomena. But this determination by combinations of functions is not causal in nature. The importance of studying combinations of functions in relation to causal analysis will then become apparent.

3.5. Interactions

Up to this point we have noted how multiple causes can produce a single effect, disjunctively and conjunctively. Now we move to situations in which a single cause produces different effects. A cause can produce different effects by being associated with some other causes. The principle, "same cause, same effect", is once again set aside.

We say that two or more causes *interact* if the effect of one cause is modified by the action of one or more other causes. This is the type of causal determination which Paul Lazarsfeld described by multivariate analysis. Interaction was the topic of an in-depth analysis by Raymond Boudon (1967). Multilevel analysis provides many illustrations of this type of causal conjunction, and Boudon's book provides a powerful critical and theoretical framework for an examination of multilevel analysis.

Beyond the causal interaction analysed by Lazarsfeld and Boudon, there is another kind of interference which explains how a single cause can produce different effects. That is what we shall now examine.

4. THE STOIC PRINCIPLE OF CAUSALITY

[2]This argument was set forth in Franck (2002, Conclusion of Part II)

4.1. The thing which undergoes the effect cooperates in the production of the effect

There is a type of interference which reverses current conceptions of causality, even more than the interferences between several causes which we have spoken of above. This type was central to the Stoic conception. Michael Frede wrote a fascinating study about the Stoic conception of causality (1980). The type of interference is this: the thing which undergoes the effect cooperates in the production of the effect.

A cylinder, a cone, or a top cannot begin to move without being pushed. The person who provides this push is thus the antecedent cause. But once the initial motion has been imparted, Chrysippus thinks that the rest of the action comes from the thing itself, and that is what makes the cylinder roll or the top turn. The actual movement is the result of joint action by the external antecedent cause and the thing which undergoes the effect. According to Chrysippus this kind of causal interference exists in all causal relations. A given effect is not simply the result of the action of external factors, but also the result of the action of the thing which undergoes the effect. Chrysippus also observes that the nature of a cylinder, a cone, or a top (that is, their matter and form) determines their movement : a cone does not roll like a cylinder, or turn like a top. The explanation of a phenomenon cannot therefore be found entirely on the side of the action and of the nature of the external factors which gave rise to the phenomenon. We must also look for part of the explanation on the side of the action and the nature of the thing which has undergone the effect.

Frede adds that for Chrysippus the thing which undergoes the effect is through its own action most often the principal cause of the effect undergone. I offer this example : the water I put on my tomato plants is a cause of their growth, but the causal auto-determination of the plants, acting jointly with the water, seems more important. In fact, if I watered stones, that would not cause them to grow. The water is only a *synergon* (something which cooperates in some work) for the growth of my tomato plants, but the plants themselves are *autotele* (they determine their own growth).

The mundane example of the tomato plants shows that the kind of causal interference which conditions, according to the Stoics, all causal relations, is easily observed and even belongs to common sense. But it is often left out of the debate over causality in philosophy of science[3] and has hardly been utilised in social sciences. By contrast it is quite familiar in psychology, at least since differential psychology drew attention to the fact that the same stimulus applied to different subjects can produce different responses.

The causal interference noted by the Stoics has a major theoretical implication. A single cause can produce different effects according to whether its action is applied to one thing or another. The variety of effects is the result of a type of causal interference different from that identified by Lazarsfeld. The principle "same cause, same effect" is disqualified once again. Another principle of causality emerges which Frede states in this way : each time something does something there are at least two active causes in play, an *external* cause and an *internal* cause (belonging to the thing which undergoes the effect). External and internal causes both have something to contribute to the production of the effect.

[3] Mario Bunge, in contrast, devotes an entire chapter to it (op.cit.ch.7)

The relation between external cause(s) and the effect produced, and between internal cause(s) and the effect produced, are both not pre-determined, because they determine each other. But this does not lead us to conclude that the effect is indeterminate. It is determined by the nature and the joint action of external causes and the thing which undergoes the effect. The effect cannot be determined by antecedent causes or by their actions alone, nor by the thing which undergoes the effect or by its action alone.

Here we encounter again the distinction between pre-determinism and determinism drawn by Bunge, mentioned above. But the argument now is different. This time, it is not merely a question of conditions which must be fulfilled in order for a cause to produce its effect. It is a question of the auto-determination of the thing which undergoes the action of external causes. The causal principle of the Stoics was admittedly inspired by their desire to safeguard moral responsibility without giving up the principle that everything is determinate.

4.2. Two ways of explaining why a cause is followed by its effect

Let's stay with the Stoics a little longer. For the Stoics there are two ways of explaining *why* a cause is followed by its effect. In order for a thing to be the cause of an effect, it is not enough that it be merely present, but in addition it must do something, be active. The cylinder will not move if I stand in front of it, but only if I push it. The knife does not kill unless it pierces the heart. And in order for a cause to come into effect, the thing which undergoes the effect must also be active. This is what Chrysippus illustrates by showing the movements of the cone, the cylinder, and the top. The conjunction of the actions of the cause and of the thing which undergoes the effect is the first of two explanations of the causal relation.

The second kind is as follows: Why do some things and not others produce the actions and reactions observed? The effect would not be produced if the thing which acts and that which reacts did not have the matter and the form that they do (Chrysippus refers to the *aitiai* of Aristotle; the reference is to what we would call today, loosely, the nature of things). The knife would not kill if it were not of iron (its matter) and if it were not pointed (its form). Thus there is a second way of explaining why a cause is followed by its effect. But this is more a matter of necessary conditions, Seneca explains; and it is fruitless to study them, in the opinion of many Stoics, because necessary conditions are often hidden or obscure, uncertain or too difficult even to imagine (what, for example, are the matter and form of tomato plants?). Posidonius is the exception. Though he belongs to the Stoic school, he carries out significant investigations of etiology in physiology, psychology, and meteorology.

The reluctance of most Stoics to study the nature of things should not be confused with the skepticism of Hume and empiricist philosophy. The Stoics judged explanation by the nature of things (their matter or form) to be pertinent but arduous and uncertain. The empiricist position, in contrast, is that the explanation of causal relations by the nature of things is an illusion, because the nature of things is not accessible through our senses. We will never know, said Hume, why heat is a constant concomitant of flame. If perchance the day should arrive, when we discover to Hume's stupefaction the reason why a flame is regularly accompanied by heat, the Stoic would rejoice, and cease to maintain that it was useless to seek to know the nature of heat.

Why should we then continue, following empiricist philosophers, to hold that scientific investigation must limit itself to the establishment of absolute or statistical regularities between two or more events?

In medicine, in order to explain a disease, we look both at the physiological or biochemical structures of an organism (forms and matters of the organism) and at the actions which may have caused the sickness : what did he eat last night? Have there been other such cases at his school? Has he been smoking long? etc. This is a familiar example of a scientific investigation which tries to explain certain effects not only by seeking the action of causes which might have called forth the effects, but also by searching on the side of the nature of the things which undergo the effects.

5. NON-CAUSAL DETERMINATIONS

At the end of a long and meticulous work of elucidation of the traditional notion of causality, Mario Bunge (1979) identified three major characteristics of causal determination: linearity, unidirectionality, and externality. These three characteristics which are attributed by the tradition to causality are mostly borne out by experience. To question the linearity of causal determination is to assume the obligation of taking into account, all at once, all the factors which might contribute immediately or distantly to the production of an effect. This makes analysis impossible, and fails to recognise that chains of events exist which can be distinguished from the circumstances which accompany them. Similarly, we must retain the unidirectionality of the causal relation because it accounts for the preponderance of action which one variable quite often exerts over another. Finally it goes without saying that many causes are external to the thing which undergoes an effect. There can then be no question of giving up these three characteristics of causality. But must we then ignore determinations which are not linear, not unidirectional, or which are internal to the thing which undergoes an effect? Quite the contrary - when we specify the nature of causal determinations as Bunge has done, we see more distinctly the existence, in nature as in social life, of forms of determination which are not linear (the case with multiple causation), not unidirectional (the case with reciprocal actions), and whose determining factors are not exclusively external to the thing which undergoes the effect (as in the case noted by the Stoics, and this is also the case with phenomena of emergence, which we will discuss below). Such determinations are not causal, in the sense that they lack one or another of the three characteristics of causal determination.

The forms of multiple causation I have examined are not strictly causal because they do not satisfy the criterion of linearity. One may nonetheless speak of them as causal determinations for this reason: these forms of multiple causation restrict significantly the number of factors considered as causes of the effect, and try to differentiate these factors from all the circumstances which contribute to the production of the effect. This is not absolute linearity, but it is sufficient for us to isolate, from out of the welter of all kinds of factors which may contribute immediately or distantly to the observed effect, a core or chain of causes which generate the effect.

Besides causal determinations, Bunge lists seven other kinds of determination : quantitative self-determination, reciprocal action, qualitative self-determination (dialectical determination), statistical determination, structural determination, teleological determination, and mechanical determination which combines quantitative self-determination, reciprocal action, and causal determination. Bunge adds that this inventory is not complete and underlines the fact that in scientific practice, causal and non-causal determinations are combined in different ways.

The way in which Bunge differentiates non-causal determinations is open to debate. One might propose other classifications or lists (see Franck, 1994) since, as Bunge says, the types of determinations can combine in different ways in the practice of research and explanation. But this is not the place to discuss that. My aim is rather to draw attention to the gain which multilevel analysis can realise from considering non-causal determinations. I will begin by reviewing the manner in which the 18th century discovery of reciprocal action, in physiology and even earlier in mechanics, allowed people to account in rational terms for phenomena of emergence. I will base myself upon the concept of emergence in order to propose a theoretical definition of the notion of a social "level". Then, I will associate the concept of level with that of system, and try to show how causal analysis and systems analysis can be combined, in order to do justice to relations of determination between social levels.

6.THE NOTION OF RECIPROCAL ACTION

The various causal interferences which we have examined up to this point are unidirectional: they do not take into consideration the action which the very thing which undergoes an effect can exercise in its turn upon the thing or things which exert the first causal action. We will now look into the implications of reciprocal action.

The need to call on a notion of reciprocity of actions between the thing which determines and the thing which undergoes that effect became evident in the new science of physiology born in the 18th century, and reciprocal determination was commented on in philosophy quite early. The different parts of a living organism, Kant says (1790), form a whole by being reciprocally cause and effect of each other. Drawing attention to reciprocal causality as it had been observed in the physiology of living organisms, Kant inspired Hegel's dialectical logic, and he started the philosophy of nature which flourished during the period from Schelling to Bergson. Still later, the notion of reciprocal action reappeared in currents of systems analysis: a system gets defined as a complex of elements which determine each other. Reciprocal action also inspired the notion of *feedback*, and determinations of this type have become quite familiar to us as involved with the automatic control systems which operate household appliances.

Still, the concept of reciprocal action was already central in classical mechanics before it was established in physiology, as Mario Bunge emphasises. By affirming the principle that for every action there is an equal and opposite reaction (Newton's Third Law), Newton broke with the unidirectional character attributed to determination by Scholastic thinkers. Before Newton, Galileo and Descartes had introduced the principle of inertia, abandoning the scholastic principle which stated "everything that moves is moved by something else, opening thus the way for the idea of self-determination. Bunge (1979, II.4.4 and *passim*) combats over many pages the long-standing confusion between mechanics and causal explanation. The same confusion, in the 19th century and still in the 20th, fed arguments made by those who demanded a specific methodology for the study of living things, different from the one which ruled physics [4]. The same confusion between mechanics and causal explanation still nourishes the demand in some schools of social science for a specific methodology for the study of Humankind, one different from the supposedly causal methodology employed in physical and biological sciences.

This brief historical review must suffice to suggest that the concept of reciprocal action, far from being marginal with regard to the concepts of linear and unidirectional causality, is on the contrary a prize possession of both physics and biology. That is why the concept has had so much importance in the history of ideas since the 19th century, up to the present. The attention which social science has given it in certain periods, for example in Marxist economy, or in the systemic current of thought, was quite well founded.

Still, it would be imprudent to present reciprocal action as an alternative to unidirectional causality, as has often been done. There are at least two reasons for not reopening that area of controversy. These were clearly set forth by Bunge (op. cit., ch. 6) and I will review them here.

First, the ontological point of view must be distinguished from the methodological. Bunge was not afraid to write that the unidirectionality of causation is ontologically inadequate since all known actions are accompanied or followed by reactions, that is, since the effect always reacts back on the input unless the latter has ceased to exist. But unidirectionality of causation is often a hypothesis leading to adequate approximations and, more often than not, it is the sole practical course that can be taken in many cases; hence, it is methodologically justified.

Second, if unidirectionality of causation does often lead to adequate approximations, it is because in reality most reciprocal actions are not symmetrical, that is, there is a strong dependence of the effect upon the cause, with a negligible reaction of the output back on the input. Bunge underlines the necessity of being able to isolate predominant aspects, and definitely genetic, hence irreversible, connections. To view society as a muddle of reciprocal actions standing all on the same level would make all explanation impossible. We are thus led to recommend, on the methodological level, a complementarity between unidirectional causal determinations and reciprocal determinations.

This valuable review encourages us, on one hand, to look cautiously into ways of introducing reciprocal determination into multilevel analysis, but also to seek means of identifying, among the numerous interconnections which may exist between factors of various levels, those interconnections which predominate. Multilevel analysis will always be doing less than it should in the eyes of those who wish science to be the representation of the totality of the universe - or the social universe - as a system of reciprocal action. But it is more important not to disappoint those who, less ambitiously, will ask why these interconnections have been chosen, and not others which are in their view as important or more so. But as I showed above, the way to identify the most important of the many interconnections which may exist between

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[4] "If the romantics had been better acquainted with Newtonian mechanics, they would not have felt justified in decrying it, but might have found in that science the germs of three categories of determination of which the *Naturphilosophen* had been very fond, namely, self-movement, reciprocal action, and inner 'strife' of opposites." (Bunge, 1979, p.116)

factors at different levels is to take as guide the combination of functions which is necessary for the production of the phenomenon one wishes to explain.

7. THE NATURE OF LEVELS

7.1. Emergence

Reciprocal determination can lead in the direction of two different kinds of effects. In the first kind, it is observed that the factor which exerts a primary action on some other thing also in turn undergoes, in reaction, a quantitative or qualitative variation. A classic example is that of the predator and its prey: the predator progressively decimates the prey species until that species becomes too few to feed it, and then its own numbers decrease, which permits the prey species to multiply, allowing the predator species to expand once again. We have here an example of a *causal cycle*, analogous to those which operate in automatized machines. But factors acting reciprocally can also integrate into a new unity. This second kind of effect due to reciprocal determination is the one which has so influenced the history of ideas since the 19th century. The emergence of new unified wholes due to the reciprocal action of certain components is a spectacular effect among living creatures. How can we explain the fact that the various components of an organism, by being reciprocally cause and effect of each other, form a whole? This question has always been an intriguing one. Still, the emergence of new wholes as a result of reciprocal action among their parts is not particular to living organisms. Hegel at an early date raised this type of reciprocal determination to the level of a universal principle, and sought to conceive the logic underlying it.

One part of the mysterious character one has often seen attributed to phenomena of emergence comes, I think, from the fact that many are tempted to picture to themselves the emerging entity as something different from the elements from which it emerges. Is the organism other than its cells? Is water something other than the hydrogen and oxygen which it is made up of? The whole does not subsist beside, or above, or around its parts. The organism is not an envelope which contains the organs or cells, the container of a content. The emergent entity is nothing but a combination of reciprocal actions between component parts of that entity, in conformity with a determinate structure.

We must nonetheless recognise that the emergent entity has properties which its component parts do not have. Water has properties that neither oxygen nor hydrogen have. Organisms have properties that cells don’t have. This means the combination of reciprocal actions between the component parts in conformity with a determinate structure is not less real than the parts themselves. Think of a clock. It is the combination of reciprocal actions between the parts which makes them a clock. The clock is not less real than the parts of which it is made.

Can the concepts of reciprocal action and emergence help us attack the question of the nature of social levels, and the question of the nature of determinations between social levels? That is what we shall now see.

7.2. Matter and form

In his book *La logique du vivant* (1970, p.323), Nobel laureate François Jacob wrote : "Living beings construct themselves (...) through a series of packages. They are arranged according to a hierarchy of discontinuous groupings. At each level, unities of fairly well-defined size and more or less identical structure, unite to form a whole at the next level. Each of these unities constituted by the integration of sub-unities can be designated by the general term *integron*. An integron is formed by the assembly of integrons of a lower level; it participates in the construction of an integron at a higher level."

Molecules form cells, cells form "populations" of cells, and those populations form organisms. But Jacob added that organisms themselves unite to form "integrons" of a higher level, as populations of individuals. Individuals are linked together by "systems of communication which no longer function within the organism, but between organisms" (op. cit., p. 339). In humans, "this brings about new systems of communication, regulation, memory, which function at a higher level than the organism. (...) Thus is constituted a new hierarchy of integrons. From the organisation of families to the modern State, from ethnic groups to coalitions of nations, an entire series of integrations is founded on a variety of cultural, moral, social, political, economic, military, or religious codes, etc. (...) with their codes, their regulations, their interactions, the objects which are constituted by cultural and social integrons go beyond the explanatory schemas of biology. Once again we have to do with the integration of elements which are themselves integrated" (ibid., p. 341-342).

Jacob's approach is hierarchical, and this approach is customary in biology, though the determination of hierarchical levels may vary according to one's program of research. But Jacob had the audacity to extend the hierarchy beyond biology, while admitting that the explanatory schemas of biology could not explain any modes of integration which might be at work at higher levels.

How can we conceive this hierarchy? Can we represent such a hierarchy to ourselves as a "series of packages" or as a "box made of boxes" or "Russian dolls", as Jacob writes? Susser and Susser (1996) have more recently employed the image of Chinese boxes. But such metaphors are misleading. They risk making us forget what Hegel commented on often, which I recalled above : the emergent entity is nothing but the combination of the component parts from which it emerges. That which differentiates an "integron" from the entities of a lower level that go to make it up, can only be the fact that the lower-level entities are combined according to a particular structure in the higher entity. It is the structure which makes the difference between higher and lower level. And it is the structure which explains the appearance, at the higher level, of properties which did not exist in the lower-level entities. This applies to social levels in which multilevel analysis is interested, just as much as it does to levels which have for a long time been identified in biology within living creatures. And we begin thus to form a more precise idea of what a hierarchy of social levels is.

Let's call the components of an emerging entity its *matter*. The structure to which the relations between these components conforms we can call the *form* of the emerging entity. We can then say that the relation between two social levels is one of matter to form, and of form to matter, depending on whether we are ascending or descending the hierarchy of levels.

That which is the *form* of a *matter* of a lower level is the *matter* of a *form* on a higher level. The same social entity is thus both *matter* and *form* depending on whether we place it in relation to the social entity on the higher level or the lower level. Aristotle was the first to show that things are both matter and form at once. This is what we call *hylemorphism* : "hyle" means matter and "morphe" means form. I attempt, for my part, to benefit from aristotelian hylemorphism insofar as it can clarify the nature of levels in social life, as can also be done for levels in biology.

8. FACTORS AND SYSTEMS

The nature of levels such as they may be conceived by the aid of the philosophical concept of hylemorphism can help us clear up the question of the relations which occur between factors and systems. This question was raised by Diez Roux, and the need for epidemiology to return to systems analysis has been endorsed by a number of writers in recent years. The need is not less great as regards other disciplines, I think. But how are we to understand the attraction of systems analysis? Often we expect from systems analysis a sort of extension of causal analysis. This would mean increasing the number of variables to which one can impute an influence over the phenomenon one wishes to explain, and then establishing between these variables a network of causal relations or relations of functional dependence which would allow us to understand how the various influences work together.

But a quite different benefit comes from conducting systems analysis in the light of hylemorphism. We can seek to know which determinations are worked by the system upon the factors which belong to this system, and which exercised by the factors upon the system. It is, then, the relation between factors and the system they belong to which must be clarified. How does the system influence the factors, and how do the factors influence the system? The following treatment applies to this second version of systems analysis.

Let's link the concept of system to that of emergent entity which we used up to now. A system emerges from the combination of its elements. These act upon each other, some in a unidirectional way, others in a reciprocal one, and we call them factors. These are the matter of the system. The system is nothing other than the factors which compose it, except that in a system the action of factors on each other conforms to a definite structure, a structure that we call the form of the system. It is because of this form that the system acquires properties the factors which compose the system don't have. Now that we have linked these concepts, system and emergent entity, we will be able to treat the relation between factors and their system as one of matter to form.

8.1. The factors influence the system

Our examination of the INUS condition of Mackie can help us now. We saw that the INUS condition's necessity was based on another kind of necessity. It was based on the combination of functions which is necessary for the production of the observed effects. For example, the necessity of the short-circuit with regard to the fire breaking out - in the absence of other causes - is based on the necessity of some flammable materials being ignited. The functions (that of igniting some flammable material and the function of catching fire) were performed by the short circuit and the curtains, let's say. These functions could have been performed by other factors**.** The short circuit and the curtains are the matter of the system. The form (the structure) of the system is the combination of the short-circuit and the curtains, and it is also the combination of their functions**.** We must take care not to confuse these two aspects of the form of a system : this form is at once a combination of factors (let us call this combination *empirical*) and a combination of functions (let us call this a *theoretical* combination).

If the short-circuit had not set the curtains on fire, the fire would not have occurred. We have here a case of conjunctive multiple causation : the fire is the effect of a conjunction of the short and the curtains. But this is also a case of another kind of determination : if the short-circuit had not caught the curtains on fire the system, that of the causal conjunction of short and curtains, would not have emerged. Within conjunctive multiple causation, there is a different kind of determination: the determination of the conjunction of factors (that is, of the system itself) by the factors themselves.

The distinction made here between production, by the factors, of the system which connects them, and the production of the properties of the system (here, the fire) may seem a bit fine in the example, but its importance appears when the production of the system covers a long time. For example, the railway system emerged and continues to emerge daily from its component parts (railway workers, a signalling system, the rails, freight trains, etc.) and it changes as a result of action by those parts, as when the introduction of new materials, new technologies, or new investment capital occurs. The railway system is determined by its parts, and this determination is not to be confused with the determination, by those same parts, of the properties of the railway system, for example its transport capacity. Another example: the school system is reproduced every day by its many parts, by the various job categories, budgets, learning techniques, administration, etc. One might study how these many parts or some of their characteristics (the number of students in class, the type of programs offered) contribute to the properties of the school system (for example the percentage of passing grades). But one could also study how these parts or characteristics, acting on each other, influence the evolution of the system itself. That is what the second version of systems analysis proposes. For example, has the introduction of computers in classes transformed the school system's structure (i.e. the *theoretical* combination of functions and/or the *empirical* combination of factors)?

Let us specify what this influence of the factors over the system consists. We return to Mackie's example. If the fire had been started, not by a short, but by a leak from a gas tank and the striking of a match, the emergent system would have been different. The theoretical form of the system (the combination of two functions, that of igniting some material and the function of catching fire) would be unchanged, but its empirical form (that is, the combination of factors) would no longer be the same, since the factors were different. It can also happen that the form of the functions of the system changes. That would be the case if, for example, the introduction of computers into schoolrooms changed the combination of functions of the school, such as education, selection, socialisation, child care, professional training, etc.

8.2. The system influences the factors

Systems analysis, understood not as an extension of causal analysis but as the analysis of relations between the system and the factors from which it emerges, offers also the possibility of studying the influence of the form of the system upon its matter. This influence is of two kinds : one influence comes from the combination (which we have called *empirical*) of the factors making up the system, and another from the combination of the functions (*theoretical* combination) of the system. The first kind is illustrated by conjunctive multiple causation. Each of the causes which combine to produce an effect is incapable of producing it alone, yet if any of them is lacking in the causal combination, the effect will not occur. Thus it is the empirical combination of factors which determines the causal action of each one. In other words, the causal power of each factor is generated by the system of factors of which it is a part. No factor can exercise its causal power outside the system. For example, away from the curtains, the short is no longer the cause of a fire. This attests the quite large role systems analysis is destined to play (as analysis of relations between factors and their system) in causal analysis. Causal explanation can vary from one system (one environment of factors) to another. Systems analysis proposes to study the influence upon causal relations due to the system itself.

The influence exercised by the system's combination of functions upon the factors is even more important. The system defines those functions which must be carried out by the factors in order to produce the system properties. For example, the school system specifies a selection function for student tests. When a test fails to perform that function, it is dropped, or revised by its author, even if it still performs other functions properly, such as the function of evaluation. This happens when all the students get the same grade, for example. Inserting people (teachers, students, administrators) or any other thing (tests, school plays, science fairs) into their functions or suspending them from such functions - this is performed not by the system, but through other factors (for example by school rules, evaluation procedures, punishments from other acting persons etc.). But it is within the limits of their functions defined by the system that factors and persons, acting within the system, can exert causal force. In other words, the system's combination of functions limits the range of causal actions possible for actors and factors.

9. A SOCIAL PHILOSOPHY

Many aspire to better understand how the social and natural environment can influence behaviour, ideas, mores, and institutions, to say nothing of diseases, birth rates, immigration, etc. The burning question of the influence of the environment on our lives finds an answer - at least in conceptual terms - when we express the question in terms of a relation between a system and its elements in the manner of hylemorphism (form and matter). The environment (understood as system) does not act upon us or the world around us as a cause which produces an effect. The determination produced by the environment is of two kinds. First, the combination of factors (persons and things) composing a particular environment (the *empirical form* of the system), brings about for each of these factors some causal power. None of these factors could exercise the causal action proper to it outside of the environment to which it belongs. Second, that which is possible to do is limited by the combination of social functions of the system (its *theoretical form*). The combination of social functions of the system defines the range of possible actions which can be performed by its agents or by other factors.

By defining the range of possible actions, and in conferring upon human and non-human factors the causal power they are capable of exercising with regard to social life, the environment defines possible behaviours, ideas, mores and institutions, as well as possible diseases, birth rates, immigration rates, etc. Must these constraints imposed by the system be interpreted as pre-determinations? No, because we have learned above that social systems and natural systems do not fall from the sky, and are not invented by gods or demons. They are emergent. They are the result of reciprocal actions performed by the elements which are the component parts of these systems. The social environment exists only because it is reproduced every day through the actions of humans and the things which surround them, and the social environment changes under these influences. A social system is nothing other than the emergent form of social life. This form is made up of an empirical form of relations between social elements, and a theoretical form of combinations of functions which the elements cooperate in carrying out. When social relations change, the environment changes.

As may be inferred, systems analysis comports a social philosophy, in the sense of a general conception of the place of humans in society. But we should not forget that this general conception was the result of an effort toward the elucidation of the concept of a system which has been continuing since the 18th century, beginning in the natural sciences. The concept of system does not result from this social philosophy; rather the reverse. This means that we can continue to improve the general philosophical conception of society if we continue to refine the concept of a system, basing ourselves on the natural and human systems studied by various sciences.

10. CONCLUSION. CAUSAL ANALYSIS, SYSTEMS ANALYSIS, AND MULTILEVEL ANALYSIS

The constraints exercised by the form, both empirical and theoretical, of the social environment upon everything which can occur in it are very strong. We have seen what they consist of: these are not causal determinations. The constraints consist in delimiting what is possible, furnishing humans and things with causal power for a moment, or preventing them from exercising it. Yet such constraints are little studied in social sciences. More often than not we are satisfied today to study individual characteristics in order to explain social life. Why? Many reasons could be adduced to explain this turn in research in social science. One particularly interests us here: we seem to lack a methodology capable of analysing the constraints imposed by the environment. Can multilevel analysis help us to achieve such analysis?

First, multilevel analysis allows us to discern the influence upon behaviour of group characteristics and of other characteristics of the environment. Multilevel analysis matches thus the ambition which originally characterised 19th and 20th century social science. One wished for example to understand why crime rates were higher in some urban areas, or why rural life was transformed by commercial exchange, or why Protestants committed suicide more frequently than Catholics. With multilevel analysis, we have an instrument which can combine individual characteristics and collective or natural characteristics, which might allow us to escape from the ecological fallacy, and from controversies about whether the individual or the collective is to be given priority in explanation (see Courgeau in this volume).

Multilevel analysis also allows us to measure the influence of the environment, taken as a whole, upon some characteristics of individuals or of groups or of things and upon the correlations observed between characteristics from different levels. This is accomplished through comparisons between observations from different geographical regions, or from different social environments, e.g., groups of students, schools, urban neighbourhoods, etc.

Yet it is important to distinguish the influence exercised by the structure of some environment (i.e. its empirical and its theoretical form) from the influence which a number of characteristics of the same environment may exercise. This distinction seems hitherto neglected. We generally interpret differences observed from one region to another, or from one social environment to another, in causal terms only, and we lose all benefit from the distinction proposed above between causal determinations and systemic determinations. Measuring the environment's influence is not yet explaining this influence. It is the structure of the environment which explains why the observed correlations may vary across regions or social environments. In order to explain the influence of the environment (especially of the environment's empirical form, as we saw in our discussion of Mackie's thesis) upon the correlations observed between social characteristics from different levels, multilevel analysis must open itself up to new procedures, those of the analysis of system functions. The study of the combination of functions which are carried out in different environments (group of students, school, company, sports team, labour union, urban neighbourhood, army, State, etc.) should permit, it seems to me, a considerable increase in the fruitfulness of multilevel analysis[5].

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[5]Is there a dependable way of knowing the combination of functions which governs the correlations we are able to establish? This question was the object of an in-depth examination in the first volume of the Methodos Series (Franck, 2002) and I refer the reader to that work. That book shows that we can construct the combination of functions of a system by studying its properties, and I drew attention to the fact that this procedure is common in natural science, and not different from the procedure which was called *induction* in the 17th century (Bacon, Galileo, Descartes, Newton, etc.) before the reinterpretation of induction by empiricist philosophy (Hume, Mill, Hempel, Popper, etc.).

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