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Book review

Review of Reductionism and the Development of Knowledge, T. Brown & L. Smith (Eds.); Mahwah, NJ: Lawrence Erlbaum, 2002

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Reductionism and the Development of Knowledge is a collection of well written essays that are all are based on presentations held at the 1999 Annual Symposium of the Jean Piaget Society. Each essay discusses an aspect of the question if human knowledge as expressed in one scientific domain can be translated in terms of another scientific domain. For instance, can psychological phenomena be stated in terms of brain states? The 19th century founding fathers of psychology, Wilhelm Wundt and Franz Brentano argued that a reduction of psychological phenomena to physical ones is impossible. Physical phenomena, according to them, should be the subject matter of the (physical) sciences [*Naturwissenschaften*]. Mental phenomena, however, would be qualitatively so different from physical ones that they cannot be studied in the same manner as physical phenomena. The scientific research of mental phenomena, then, should take place according to different methods developed by a different group of sciences, namely the mental sciences [*Geisteswissenschaften*].

However, evolution theory would give rise to the idea that mental phenomena are indeed reducible to physical ones. Darwin explained phenomena like human emotions, human smiles and the – supposed – differences between human males and human females in terms of his evolution theory. Yet, this way of explaining human characteristics would reduce psychology to a branch of biology; a conclusion diametrical opposed to the one reached by the founding fathers of psychology.

The first essay *reductionism and the circle of sciences* by Terrance Brown is a pleasure to read. Arguably the traditional view on reduction of sciences is a linear and hierarchical one. Mental phenomena are generally believed to be caused by brain states; and brain states to be the result of chemical processes that, in turn, can be explained with the help of physical laws. However,

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the reduction does not end there. Physical laws are formulated in mathematical terms like Einstein's $E = mc^2$. If one wants to keep a linear hierarchy, then mathematical laws cannot be a product of the human mind and therewith a psychological phenomenon. If, however, mathematical laws are not human inventions then they must be 'just' human discoveries. That is, they are something objective. Proponents of this view may be inspired by the Judeo-Christian tradition where these laws are willed by God. Einstein stood squarely in this tradition when he defended his views with the argument that God does not throw dice.

Piaget (1967) disagreed with the above sketched linear hierarchical model. His analysis seems to be more in line with Darwin's theory of evolution. The human brain is so evolved that it has mathematical abilities, just like it has the capability, for instance, to feel emotions. Mathematical laws, in this view, are the product of the human mind; they are human inventions. To quote Brown: "It is after all, people who create logic and mathematics" (p. 21) and with this belief Piaget had to conclude for a circular model of reduction. In Browns' words: "The sciences are cyclically related for the simple reason that there is nowhere to look for an explanation of logico-mathematical phenomena other than in psychological and social activity" (p. 20/21). The circular model goes as follows: psychological phenomena are dependent on biological phenomena that, in turn, depend on physical phenomena that, in their turn, are stated in mathematical laws; and with mathematical laws we are back at the beginning of the circle namely at psychological phenomena.

The second essay titled *understanding*, *explanation*, *and reductionism: finding a cure for Cartesian anxiety* is a scholarly contribution by Willis F. Overton. I will not discuss Overton's analysis of the thoughts of Descartes and other scholars but will only stand still at his analysis regarding the relation between interpretation and observation, and at his analysis on causality and action patterns. Overton points out that observation and interpretation are dialectically related. Observation, he notes, cannot be reduced to interpretation nor can interpretation be reduced to observation. Both, then, are needed to develop a scientific theory. "Interpretation identifies what will and will not ultimately count as observations and observations determine what will and will not count as interpretation" (p. 42). An example could make this clear. The growth of a tree is explained from things like seed, soil, water and so forth. We know this from observing that a seed in soil develops to a full grown tree. However, we also observe that the growing tree stands 24 m from a house. However, that observation is excluded from our explanation because it does not fit into our account. Observation (seed and soil) and interpretation (which excludes the distance between the tree and the house) go hand in hand; one influences the other and the other influences the one. Interpretation and observation are dialectically related towards each other; one cannot be reduced to the other. Scientific activity, then "becomes grounded in the to-and-fro...movement of interpretation–observation" (p. 42).

Overton explains the difference between the notion of causality and the notion of action patterns with the example of a man walking across a room to greet his wife. If it were not a man and a woman who would meet, but, for instance, one billiard ball colliding upon another, a simple causal explanation would suffice. This explanation would refer to the initial states and subsequent movements of the two billiard balls. That, obviously, is not the case when a man walks over to greet his wife. In this case we need to employ terms that refer to the meaning of the encounter like intention, purpose and so forth. Hence, Overton distinguished two kinds of explanation: causal explanation that can be applied to explain the movements of the billiard balls, and action patterns that would explain the husband's action towards his wife. Or, in his words: "The two movements of explanation – causal explanation on the one hand and action-pattern explanation on the other – explain different phenomena" (p. 44). It follows that both types of explanation are compatible with each other but not reducible to one another; both types have their place in science.

In the following essay, *evolution*, *entrenchment and innateness*, W.C. Wimsatt claims that "generative systems would occur and be pivotal in any world – biological, psychological, scientific, technological or cultural – where evolution is possible" (p. 55). This statement is only intelligible for those who know what 'generative systems' are and, unfortunately, Wimsatt does not define this term. However, a few sentences further mention is made of phenomena that have markedly influenced future developments after their arrival on the scene. We find among them: the informational macromolecules RNA and DNA, spoken language as well as improvements in agricultural techniques. These phenomena are all examples of elements that are small steps in a historical development when seen in themselves, but very important breakthroughs from the point of view of the construction of the system as it functions right now. RNA and DNA made differentiated multi-cellular organisms possible, spoken language lies at the basis of human culture, and improved food production has made it possible that a growing group of humans are able to live in cities and create wealth through other means than the production of food.

Another term that Wimsatt uses but not defines is 'entrenchement'. One finds this term often in the juridical literature about rights, like property rights, human rights, the right to vote and so forth. On the moment that such a right becomes part of the juridical code of a society, it influences significantly the further development of that society. Entrenchement, therefore, as used by Wimsatt in his analysis of developing systems, seems to indicate that the element remains relatively stable and unchanged and that it has not become extinct over time. Even nowadays RNA and DNA are parts of our bodies; we still speak a language, farmers use techniques that produce much more food than they need for themselves and human rights will continue to exercise their effects on western societies as long as they remain included in their laws.

Obviously, when studying a historical development of a system, it seems worthwhile to look for elements that contributed disproportionably to the unfolding of the system and that are still a part of that system. However, Wimsatt's claim is more radical. Wimsatt denies "that there is anything that is innate as traditionally understood" (p. 61). Instead, an 'adaptive structure' like a human body or a human culture should be explained from elements that are 'deeply generatively entrenched' in the structure concerned (see p. 61). Wimsatt, then, continues to make a case that a term like 'generative entrenchement' would explain (innate) phenomena through a more "theoretical unified analysis" (p. 62) and, moreover, that 'generative entrenchement' would provide a richer account of historical developments than the traditional ones that use the notion of innateness (see p. 62). Time will tell if Wimsatt's conclusion will indeed hold up, namely that: "Generative entrenchement gives a reconstructive analysis which better fits existing claims... than any other [analysis], offers new fruitful connections and predictions, and reflects modern accounts of the relation between genes and development" (p. 77).

The next essay *reductionism in mathematics* by Jaime Oscar Flacón, Vega, Gerardo Hernández and Juan José Rivaud aims "to point out a new direction in the study of what constitutes reductionism in mathematics" (p. 101). They recognize three types of mathematics. The first type was practiced by Thales (6th B.C.) and it searched for mathematical truth that inhere in geometrical figures. Euclid, on the other hand proposed a set of basic axioms that would describe properties of space. Geometrical figures are spatial entities and, as a consequence, their properties should be deductible from the basic set of recognized truisms of space. Both, Thales and Euclid saw truth as a property belonging to the geometrical object. Thales, however, tried to arrive at these properties directly from the object itself whereas Euclid tried to reach them through reasoning from a few axioms. Contemporary non-Euclidian geometry, according to Flacón et al. has set aside the notion that truth resides in an object. Truth, for a non-Euclidian, is just what can be proven from a set of axioms. It may well be that different sets of axioms lead to different proofs and thus to different recognitions of properties of mathematical figures. It follows that, according to the contemporary mathematical view, different notions of truth may exist side by side.

Flacón et al. restrict their discussion to mathematics. However, mathematical truths differ from empirical truth. The truth of a mathematical statement is based on some premises (not on reality) and the logical validity of the deductions. As a consequence mathematicians arrive at abstract truth or statements that are not necessarily applicable to real life phenomena. Empirical truth, on the other hand, is only true when it corresponds to an outside reality. Mathematical statements do not refer and are true if they fit well in the system. Empirical ones, however, do refer and they are only true if they correctly describe what they point to. The problem of reductionism in the empirical sciences is different from that of mathematics. In the empirical sciences we have, for instance, chemical theories and biological theories. The question, then, is: Can one be reduced to the other? Chemical theories may explain, for instance, blood processes, digestion, working of neurons and brain processes. However, the theory of evolution gives also an explanation of animal organs and animal behavior. Both theories have some objects in common and therefore the issue arises if the phenomena that are explained by one theory can also be explained through the more fundamental one. Empirical theories, just like mathematical theories, lead to different truths, but in the case of empirical theories, there are different truth statements about the same objects and reached from the same premises and by the same logic and formulated in the same language. Yet, it seems that one cannot be formulated in terms of the other.

Mark Bickhard's *the biological emergence of representation* is the subsequent essay. Bickhard's central notion is that of a 'self-maintenant system' and he explains it with the example of a candle flame. A candle flame "maintains above combustion threshold temperature; in a standard atmosphere and gravitational field, it includes convection, which maintains a supply of oxygen and removes waste products, and so on" (p. 112). Obviously, a candle flame is not able to respond properly to changes in the environment; a wind can blow it out easily. The next, higher level of a self-maintenant system is a recursively self-maintenant system. Such a system "tends to maintain its own property of being self-maintenant against such changes in the environment" (p. 115). And it does so on the basis of having the capability of (1) detecting changes in the environment and (2) of selecting a – hopefully – suitable response to the changes. The critical property in a selection of a response is, according to Bickhard, that the selection anticipates happenings in the environment that likely will occur in the immediate future. That is, a recursively self-maintenant system has the capability to make predictions regarding the future of its environment and it is able to do so on the basis of a (crude) representation of the environment. Representation and a primitive form of goal directedness have emerged. The system's predictions regarding the future may be right but may also be wrong. The members of the next higher level of these systems have developed the ability to learn from their mistakes. Bickhard argues that these more sophisticated systems must represent their environment and their own responses by means of several levels. Let us assume that a system tries an action two more times in case it has no success and then tries a different one. The system must be able to monitor itself and remember that it has tried an action less than three times before selecting another option.

Bickhard notes that in this model representation does not exclusively mean a representation of characteristics of the environment – arguably the standard view – but that representation also includes a range of actions as well as a mechanism that can select a potential successful action among the available ones, and, in the more sophisticated systems, also can keep track of its selections.

In *the role of systems of signs in reasoning*, Terenza Nunes set out to integrate Piaget's and Lev Vygotsky's theories of cognitive development by inserting them both in the framework of systems theory. Systems, Nunes notes, are characterized by complexity, organization and development. All these are, obviously, elements in any theory of cognitive development and therefore also of Piaget's and Vygotsky's. Both theorists agreed that development proceeds through stages, that the acquisition of knowledge is constructive in character and that a qualitative transformation in a stage sets the ground for the next stage. Nonetheless, both theorists, according to Nunes, emphasized different aspects of development:

"Piaget investigated the developmental processes that make learning possible, whereas Vygotsky investigated the consequences of learning for further development" (p. 141). At the end of the essay Nunes discusses studies that aim to discover the strategies that people may use to solve multiplication problems. The subjects in one group of studies were children, whereas the subjects in the other group were adult workers without much formal education. Nunes uses these studies to support her claim that the theories of Piaget and Vygotsky can be integrated in an overall framework.

Luisa Morgando's *the role of representation in Piaget theory: changes over time* is an analysis of the development of Piaget's concept of representation and the ensuing criticism on Piaget's views. Morgando recognized three periods in Piaget's thinking. The first period dates from the 1920s to 1945. This was the time that Piaget observed children and developed his theory of the construction of intelligence in subsequent stages. In this period, according to Morgando, Piaget gave two different meanings to the term 'representation'; a restricted one and a broader one. In the restricted meaning, 'representation' stood for an image of a past event. In the broader meaning, it stood for the organization and integration of mental images into thought.

Morando situates the second phase from 1950s to 1960s when Piaget spelled out in more detail his notion of representation. This is also the time that he carried out experimental research with Inhelder. Morgando argues that, in this period, representation – especially in the restricted sense of an image of a past event – remained a theme of Piaget's thought but that he assigned it a lesser role than he gave to actions and operations of thought. The third period goes from the 1970s to the end of Piaget's career. Now Piaget studied the onset of representations and their importance for the planning and carrying out of actions.

Cynthia Lightfoot's *breathing lessons: self as genre and aesthetic* is the 8th essay. Lightfoot believes that "our conceptions of self underwent a radical revision between ancient and modern times" (p.179). This belief is based on an interpretation of survived texts and artifacts and the conclusion seems to me as good as the interpretation is. Unfortunately, the method on which the interpretation is based is not explicated and that makes it difficult for me to accept the view that humans have seen themselves qualitatively different over time. However, notwithstanding my doubts, I read the historical examination with pleasure. Texts and other artifacts of adolescents, Lightfood remarks, can be studied in the same manner as old texts and, according to this logic, conclusions can be reached how adolescents see themselves. Obviously, I have the same doubts regarding the conclusions based on adolescents' material, but again, Lightfoot has produced an enjoyable text. In the conclusion, the view of today's adolescents about themselves is linked to the self-view that characterizes our own époque; this, of course, according to Lightfood's interpretations of ancient and contemporary's writings.

In the last essay, *from epistemology to psychology in the development of knowledge* Leslie Smith highlights Piaget's insight that researchers who study the development of human knowledge must deal with two features of knowledge that cannot be reduced to one another. On the one hand, the researcher must observe empirical facts. For instance, when does a child realize that objects continue to exist even after they have disappeared from view? On the other hand, the researcher must take the normative aspect of knowledge into account; the researcher must assess the soundness of the child's reasoning. Piaget believed that the correctness of the logic is an empirical fact in the sense that it is a matter of fact if a child employs sound inferences and deductions or not. Developmental studies, then, must take into account empirical descriptions as well as normative criteria; they must include pure empirical material and also non-empirical information such as standards of truth and logic.

All the essays in this volume argue against simple notions of reductionism. Piaget is indeed a common source of inspiration among its authors. Nevertheless, the book is of interest to anyone who wants to learn more about the problem of scientific reductionism; also to those who are not so particularly interested in Piaget's theories of child development. After all, Piaget was one of the great psychological scholars of the 20th century and this volume proofs that his notions still inspire original research that fall outside the area he is generally recognized for, child development. I warmly recommend this collection of essays to anyone interested in the growth of knowledge.

Reference

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