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Physics Develops Unaffected by Constructivism

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Abstract:
The way physics and other parts of science work can be explained in the framework of radical constructivism. However, this constructivist view itself shows that a uniquily accepted epistemology, constructivism or any other, would not be an advantage for the development of science. Unlike physics some parts of science successfully use constructivist concepts inside their theories. Because this is the case particularly in learning theory, constructivist ideas can help to improve physics teaching.

Keywords:
Consensuality, language-games, quantum theory, realism in physics, scientific education.

1. Radical Constructivism

Radical constructivism is explained by Ernst von Glasersfeld shortly as “an unconventional approach to the problems of knowledge and knowing. It starts from the assumption that knowledge, no matter how it be defined, is in the heads of the persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her experience. What we make of experience constitutes the only world we consciously live in. It can be sorted into many kinds, such as things, self, others, and so on. But all kinds of experience are essentially subjective, and though I may find reasons to believe that my experience may not be unlike yours, I have no way of knowing that it is the same. The experience and interpretation of language are no exception.“ (von Glasersfeld 1995, p.1). “What others understand when we speak or write is necessarily in terms of the meanings their experience has led them to associate with the sound images of the particular words - and their experience is never identical with ours.“(p.48).

Knowing is meant in a very wide sense, in fact all mental processes are viewed as constructions. It begins with the perception of objects in space and time, with forms, colors, odours and sounds, and eventually it ends in operations and actions. All this is loaded with feelings and emotions. There can be no doubt that animals, too, share with us at least a considerable part of these performances (without language, but constructivism does´not regard

findings of modern cognitive neuroscience. Of course, as will be explicated below for science in general, neuroscience itself is a construction of humans. But this construction is self-consistent (cf. Roth 1994) by regarding all mental processes as produced by the brain. In particular, our human brain also produces our perception of fellow-creatures, of our social neighbourhood, and all we regard as specially human, such as language, science and philosophy. This becomes drastically evident in pathological cases of cognitive and emotional deficits and abnormities (Sacks 1985,1995, Damasio 1994).

To be „radical“ means to accept the subjective character not only of emotions, of pleasure and pain, but also of the perceived world and the knowledge about it without evasions and tricks. Despite this fact, there is communication and understanding; I have the impression that I understand my partners and am understood by them. I perceive actions in groups of other persons and my own actions in social groups, which I value as being successful in parts, and I experience that others also value them as being successful. Of course communication sometimes fails, and some actions obviously do not reach their goals. However, these failures are apparent only on the background of many positive cases. Think about all the organisational structures of our civilization, for instance the transportation system. Thousands of airway personnel function very precisely in such a way that the passenger can rely on the schedule, at least in most cases (von Glasersfeld´s example on p. 138).

According to von Glasersfeld, constructivism is obliged to provide a model capable of showing how this comes about, in spite of the informational closure of the individual cognitive system. Starting points could be found in his theory of constructing agents. He demonstrates how in a process of recurrent interactions with the persons of my social neighbourhood my constructions find a corroboration by these fellow-beeings. I begin to explain, predict and attempt to influence the behaviour of these other persons. My “experiental field becomes populated with models of others who move, perceive, plan, think, feel, and even philosophize, others to whom one imputes the kinds of concepts, schemes, and rules one has oneself abstracted from experience“. I use the models for prediction, and “if then the other does what I predicted, I may say that the piece of knowledge was found to be viable not only in my own sphere of action but also in that of the other“. This so-called second-order viability “plays an important part in the stabilization and solidification of the experiental reality“ (all citations from p.120).

If a similar process takes place in other persons interacting with me a “consensual domain“ arises, as it was called by Humberto Maturana. Ernst von Glasersfeld speaks about an “intersubjective level“. “It is the level on which one feels justified in speaking of `confirmed facts´, of `society´, `social interaction´ and `common knowledge´ “ (p.120).

In that context we need to consider language in more detail. Usually, in human consensual domains language plays an important role as an instrument of communication. However, language is by no means a vehicle to transport information as is expressed by von Glasersfeld´s statements cited in the first paragraph. What is exchanged in a conversation are not thoughts or meanings or information but only words and texts. The words and texts must be associated by each participant with cognitive constructions, namely meaningful thoughts, or

“re-presentations“ as von Glasersfeld calls them. Re-presentations can produce actions and expectations due to the mental dynamics, they are located in the space of optional perceptions and actions.

In a language-supported human consensual domain, the association of words and sentences to re-presentations are made compatible between the members only by a long recurrent process of interactions, such that one´s actions meet the other´s expectations. This cannot be brought about by speaking and listening only, rather there must be a greater context of shared non-linguistic activities. Agreement can be stated only by the way of common usage. As we will see below this is likewise true in the consensual domain of science.

Originally interested in quite different problems than the constructivists, Ludwig Wittgenstein developed a concept very similar to language-supported consensual domains, namely the *language-games*. This similarity has been recognized by von Glasersfeld, too (p.133). Often misinterpreted, a language-game is by no means a game in the usual sense, and, moreover, it is nothing purely linguistic. It is embedded inseparably in an interacting community; therefore, Wittgenstein speaks more or less synonymously about a *form of life*. I will present Wittgenstein´s view in the next section, and then apply it particularly to the language-game called science.

However, at the end of this section, let me formulate two statements concerning the frequent misapprehension of constructivism consisting in the assumption of an almost unlimited freedom to make arbitrary constructions.

(1) As shown very clearly by von Glasersfeld, there are obstacles and constraints that impede some of our actions and thwart some of our efforts. We have to master a steady conflict of our expectations with these obstacles, and by doing so we arrive at more and more viable constructions, in the sense of a “constructivist objectivity“.

(2) The second-order viability experienced in consensual domains can be reasonably explained only by the assumption of universal properties of the human cognitive and emotional apparatus (Hejl 1999). It includes primitive categories of early perception as well as universal structures of social interaction. This cannot be proved, we can make such a conjecture from an internal point of view only. In any case, it is not a contradiction to “radicality“.The fact that in a concrete case I cannot know whether or not my partner has the same experience (see the text of von Glasersfeld in the first paragraph) remains true. But without the assumption of universalia a comprehensive social theory appears to be impossible.

2. Science as a family of language-games

In the second part of his life Ludwig Wittgenstein struggled with the problem of meaning after he had abandoned the picture model of the Tractatus Logico-Philosophicus (1922). In the Philosophical Investigations (1953) he discussed the theories of "following a rule", and showed that they all end up in a paradox (cf. Kripke 1982, Stegmüller 1986). A special case are the rules of meaning, i.e. material semantics. His “sceptical solution“ of the paradoxon conceives the speaker as a member of a community of language and life who actively forms his life and provides for survival by a continuous interactive process of linguistic and non-

only to such a degree as everybody agrees that the interactions are successful. Because of the inseparable connection between language and the collective life and its activities, Wittgenstein used the notions *language-game* and *form of life* nearly synonymously.

It is a long collective practice that has brought the meanings of the members of the community into line such that a person´s actions meet the other persons´ expectations. The use of the words is understood only by the members of the community (Wittgenstein 1958: "If a lion could speak we couldn´t understand him"). Wolfgang Stegmüller (1986) says in his commentary on Wittgenstein: "The agreement of the members of the language-community concerning their utterances, and the entanglement of speech activites with speechless actions constitute the form of life of the community". But the recurrent process of common acting and speaking with each other does not guarantee an absolutely reliable communication; rather, again and again it has to be tested in practice "how long the ice holds".

Wittgenstein refused to consider these problems from the perspective of cognitive psychology, in addition to his social perspective. This is critizised by von Glasersfeld with good reasons (p.134). Nevertheless, Wittgenstein´s analysis of language-games remains correct for the constructivist as well, and can be completed in a consistent way by considering the association of meanings to words and texts as a subjective process in the cognitive system of the individual[1].

No doubt, in all parts of science language plays an important role, e.g., in the form of textbooks, journal articles and lectures. All linguistic activities are inseparably embedded in the non-linguistic (observational, experimental, computational) activities of the interacting scientific community. Therefore, I have suggested considering science as the *language-game and form of life* of the scientific community (Schwegler 1992, 1999). Alternatively, if we take into account the fact that science is a complex structure of specialized sciences, then we can also speak about a *family* of language-games in the sense of Wittgenstein´s concept of family similarities.

Generally, the association of meanings to words and texts by the members of a scientific community can be coherent only in the sense of second-order viability, i.e., to such a degree as the members agree in their speaking and acting. It is therefore of greatest importance for a consensus that the production and the exchange of texts are embedded in a network of non-linguistic activities. At the beginning of their careers scientists have to learn the language-game in a troublesome process. This process comprises not only listening and reading but practical work in the lab guided by older members whereby the consensus of meanings grows via trial and error, after "many thwarted linguistic interactions and repeated cropping and adding of the [student´s] meanings" (von Glasersfeld, p.141). Ludwik Fleck (1935) called this process "the

[1] Particularly, if one tries to investigate complex language-games of large social communities (as in the case of science), where the focus is on the social behaviour, and the detailed processes in the individuals cannot be followed, Wittgenstein´s scheme may be adequate and sufficient. If, on the other side, the mental development of the individuals should be reconstructed in detail, Wittgenstein´s scheme has to be extended. This is for instance

gentle duress of apprenticeship“. It is not learning by heart of some formula and the acquiring of technical skills that makes a scientific study to last more than five years. Such a long time must be sacrificed rather for the growth process of a structure of meanings.

Only if one has realized how important non-linguistic social interactions are for the generation of a domain of consensusal meanings in science, one can understand why there is so much misunderstanding in the humanities. Wittgenstein (1975, No.9) says “Asked whether philosophers have hitherto spoken nonsense, you could reply: no, they have only failed to notice that they are using a word in quite different senses.“

The requirement that the consensual domain of the scientific community should not be abandoned makes science relatively conservative. Science cannot afford a babylonian situation. Even the famous big scientific revolutions in the sense of Thomas Kuhn have changed the conceptual structures in small parts only. The debate on commensurability has shown that such changes are not localized but distributed over larger areas of science. Nevertheless, they are small compared to the entire body of concepts and procedures. The situation is nicely illustrated by the parable of Otto Neurath (1981, p.918), in which he compares the scientists with sailors who have to rebuild their ship on the high sea under hard storms and thounderous waves. The ship must continue to be manoeuvrable and seaworthy all the time.

3. Physics and naive realism

If physics is nothing but a language-game it cannot tell us the truth about an objective reality, independent of the social community of the physicists. However, it is often assumed, in particular in discussions on constructivism, that the physicists themselves are convinced to generate the absolute truth, and even that this claim is the sole basis of their sense of profession. According to my experiences during a life-long membership in the physics community I must oppose this assumption.

I accept that the asumption expresses what many *non-physicists* think about physics. Many philosophers have misinterpreted physics in that way, and tried to make it harmless by viewing physics as being restricted to dirty matter. Even the great Kant was incapable of imagining that a different physics was possible, and in order to remain true to his philosophical work he could not but declare the principles of Euclidian geometry and Newtonian mechanics to be apriori conditions of human knowledge. He has been proved wrong by the later history of physics.

Within the scientists the members of the neighbouring disciplines of physics believe much more then the physicists themselves that physics generates truth about an objective reality. One example is biology with its expanding reductionism. (for a rejection of reductionism see Schwegler 2000).

Of course, their are also physicists who adhere to an epistemological realism. It would go beyond my abilities to investigate if these have been the majority a century ago and earlier. But there is apparent evidence that it must have changed since the physicists had to pass through the purgatory of quantum theory which blows off all naive realism. This was appreciated by von Glasersfeld (p.21) with the citation of Werner Heisenberg.

It seems nearly impossible to interpret the quantum theoretical wave function as a real object in space and time instead of an instrument to calculate probabilities for observable events, for the reason alone that it lives in a high-dimensional configuration space, and moreover, because of its collapses. If some physicists continue trying to establish a realist interpretation this may matter to philosophy, but it does not matter to physics as long as all perform the same operations with respect to the prediction of observable events.

Among the physicists of the 20th century you can find very different epistemological standpoints. At the beginning of the century, some famous physicists had been conventionalists. Both Einstein and Heisenberg started their revolutionary ideas from positivistic concepts which they left behind later. Einstein became a realist, indeed, but not a naive one[2]. Because of the difficulties with a realistic interpretation of quantum mechanics most other physicists became instrumentalists. It is not the place here to demonstrate this statement by many examples from the last decades of physics, for a very recent example see Fuchs and Peres (2000). In the fifties David Bohm proposed an interpretation that is still favored by some philosophers adhering to realism, but it is without the slightest influence in the actual mainstream physics. Some other, funny interpretations of quantum mechanics exist (many worlds, many minds, consistent histories etc) which are kept up in small isolated communities. Actually, there is a revival of the debate on Einstein´s "local realism" because now this conception is excluded definitely by recent experiments (Alber and Freyberger 1999); Stenger, for instance, has abandoned the concept of "reality" already in 1990.

Even in cases when physicists write about their search for "a true description of reality" (like Steven Weinberg 1998), one should endeavor for an adequate understanding. If constructivism and Wittgenstein´s problem of meaning are taken seriously, it is not trivial to know what is meant by the use of a word; a whole context is necessary for the understanding. When von Glasersfeld speaks about "experiental reality" (citation above) nobody would accuse him to be a realist[3]. In another part of his book (p.121) von Glasersfeld writes: "Others may be telling us (or we may believe) that they think as we do, but what they say or do shows us, as the interchange goes on, that this cannot be the case. Although the words they use are the same as ours, the network of concepts they seem to have in mind is incompatible with the one we have built up". This is likewise the case the other way round. It is not enough to read a text, but there must be an interchange with the author.

Summarizing this section, it is incorrect to state that 20th century physics is bound to one and only one epistemological position, or is sold on realism or believes in absolute truth. Rather, modern physics as a whole is epistemologically "agnostic".

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[2] There are some formulations by Einstein showing a constructivist sound (one example is cited by von Glasersfeld, p.165) but in the debate on quantum theory he has held a clearly realist position against the different versions of the Kopenhagen interpretation (cf. the references cited in the main text).

4. Physics and Constructivism

As I have shown in the first two sections, from a philosophical and epistemological point of view one can well interpret the way science works in the framework of radical constructivism. I prefer this as my personal position, whereby I recognize a wide overlap with Wittgenstein´s concept of language-games. Other physicists prefer to interpret the world and how they do physics in this world within other frameworks (as discussed in the last section). The same variety is found among researchers in the other parts of science even if they use constructivist concepts inside their scientific theories. The usefulness of such concepts taken for granted, it is a quite different question whether a unique epistemological meta-theory, e.g. radical constructivism, would be an advantage for the development of science.

Of course, with constructivist concepts a convincing theory of cognitive processes can be built up as von Glasersfeld and others have shown. It can have a strong impact on certain fields of social practice, for instance in the field of teaching where a constructivist attitude seems to be necessary. This is true in the field of academic teaching as well, where established scientists try to help the “apprentices“ to enter a scienctific community, for instance physics (a very troublesome way as mentioned in section 2). If one knows that there are no instructions, and that the interventions of the teacher into the active learning process of the student can at best give some orientation, other and perhaps better ways of teaching could be developed. Because I am not a professional in that field I can only refer to constructivists in learning theory (von Aufschnaiter 1999, 2000).

As already mentioned in the first section, in our time we observe neurophysiology approaching to psychology. Two language-games begin to amalgamate. Other parts of science have already fused. There are no longer definite demarcation lines between physics, chemistry, biophysics, biochemistry and biology. This is true with respect to phenomena and observation methods as well as to concepts and theories. However, this fusion is realized in a non-reductionist manner (Schwegler 2000). We see a patchwork of coexisting scientific domains in which one can argue, explain and deduce without contradictions. The aim to overcome the remaining borders and breaks can be proclaimed as a utopia of one unified language-game of science (Schwegler 1992, 1998) in the spirit of Otto Neurath´s "unified science" (1938). Progress on that way has to be made by the interacting scientists in an interdisciplinary work. The resulting theoretical structures cannot be foreseen today. In particular, in the case of cognitive neuroscience growing out of neurophysiology and psychology one cannot predict how many constructivist concepts will survive. I expect that information concepts will also survive[4].

The variety with regard to epistemological meta-theories will survive as well. One has to realize that even a radically constructivist psychologist *need not necessarily* support constructivism as his epistemology. This is a central point of my argument. If a construction turns out to be viable in one field, say cognitive psychology, this does not justify the transfer

[4] By the use of information concepts viable and useful explanations could be given which will subsist. To understand it better one has to realize that the word “information“ has several

into other fields., and it certainly cannot be concluded that the construction becomes an absolute “truth“.

This statement brings me back to the question whether the language-game of science needs a uniquely accepted epistemology. From the point of view of both constructivism and the concept of language-games the answer must be definitely: no.

The rules of the language-game "science" are defined primarily in an implicite manner by the procedures of the scientific community. By following these rules the members of the community build up a social construction. However, to participate in this process does not depend on considering it as a pure construction, a construction of a so-called reality or a construction of whatever, as long as the rules of the community for the language-game are observed. What the individual member thinks about the fields outside the game is irrelevant. Philosophically, he or she can believe in Platonism, scholastics, conventionalism, positivism, instrumentalism, constructivism, he can come from different cultures, he can be roman-catholic, muslim, hindu or buddhist - and yet play the game correctly.

What is worse, epistemological monism would be a disadvantage, in fact. For at a certain point in the historical development of science the philosophical or ideological position of a scientist can have contingent inspiring effects, because a good idea to solve a problem or puzzle, to undo a knot in the net of constructions can come from everywhere. Kekulé came to the ring of benzene by the dream of a snake biting in its tail. Einstein and Heisenberg came to their new ideas by being guided by principles of positivism. After the new ideas have become accepted by the community as functioning, their origin is thrown away and forgotten. It will happen this way in the future, because science (including physics) will be never completed; there will be new knots all the time.

5. Conclusion

My article shows that the way physics and other parts of western science work can be well interpreted in the framework of radical constructivism by considering them as a language-game in the sense of Wittgenstein.

Empirically, it is obvious that a scientist need not be a constructivist himself in order to be able to participate in the game successfully.

This is understandable just from a radical constructivist point of view. Radical constructivism does not claim that all scientists should adhere to a constructivist epistemology. On the contrary, it would not be an advantage for the development of science if constructivism would be the only accepted meta-theory. Because the new ideas necessary to improve science by more viable constructions can come from everywhere as is shown by the history.

6. Literature

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