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Is Glasersfeld's Constructivism a Dangerous Intellectual Tendency?

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Paper type: Conceptual paper **Approach**: philosophical–epistemological **School:** Radical Constructivism **Purpose:** Radical Constructivism has been subject to extensive criticism and denigration such as that it is a naturalized biologism which supports an "anything goes" philosophy of arbitrarily constructed realities. In an extreme case RC is equated with intellectual silliness. These accusations are to be refuted. **Approach:** Based on the concept that cognition can work only with experiences, we investigate the question of where their apparent order comes from. Arguments are presented that favor the amorphousness of the "external" world. To support the idea of "internal" order we review results in formal network research. **Findings:** The properties of networks suggest that order arises without influence from the outside. **Conclusions:** RC based on network models (a) does not need any empirical support and is therefore no biologism nor naturalism, (b) forgoes arbitrariness, and (c) goes beyond narrative (armchair) philosophy. **Key words:** amorphousness, naturalism, closure, reality, random Boolean networks, scale-free networks, small-world networks.

INTRODUCTION

Radical Constructivism (RC) has been subject to extensive criticism and denigration. The most frequent accusations include the allegation of simply repeating old (and often outdated) philosophical positions. RC is reproached for being: a naturalized biologism which refutes itself as it gets caught in argumentative circles; a form of extreme idealism that unavoidably results in solipsism; an "anything goes" philosophy claiming that realities are arbitrarily constructed, which makes *all* constructions of the same standard irrespective of whether they are science or voodoo; or a flavor of postmodernism with applications to literature and education only. Probably the fiercest statement reads, "I have a candidate for the most dangerous contemporary intellectual tendency, it is … constructivism … Constructivism attacks the immune system that saves us from silliness." (Devitt 1991). This is a serious accusation. The author is right to be concerned about threatening tendencies in the academic world. However, he is wrong about constructivism. It is my objective to refute these claims and to present RC as a streamlined uniform discipline.

THE WORLD AS A BLACK BOX

For Ernst von Glasersfeld, searching for knowledge can be compared with the situation of a subject who is facing a black box, and who is trying to read sense into its behavior. "[The world] is a black box with which we can deal remarkably well." (Glasersfeld 1974/2007, p. 81). In his view, experience "basically consists of signals… [any] representation of an 'outside reality' will necessarily be based on such regularities as they can establish in the experienced signal sequences… any representation of the outside reality will be a model of an inaccessible black box in which the input, registered as effector signals, is systematically related to the output, registered as receptor signals" (Glasersfeld 1979, p. 79).[1]

[1] The concept of the black box was extensively discussed by Ashby (1956). See also Glanville (1982).

Central to Glasersfeld's theory are recognition patterns that enable us to recognize experiential sequences. The construction of reality is based on the recurrent extraction of repetitive patterns from the stream of experience. That we succeed in recognizing patterns says nothing about any ontological existence of these patterns, so even "if we posit causes for the sense data […], this does in no way entail that these causes exist in the spatio-temporal or other relational structures into which we have coordinated them" (ibid. p. 82).

The relationship between experience and regularity was, among others, explored by Ernst Mach (1912/1960). In his concept of the "economy of thoughts" he emphasized the importance of compressing experiences into laws. He wrote that it "is the object of science to replace, or *save*, experiences, by the reproduction and anticipation of facts in thought. Memory is handier than experience, and often answers the same purpose" (p. 577). Likewise, Herbert Simon defines science as pattern recognition. He characterized the "discovery" of laws as "detecting the pattern information contained in the data, and using this information to recode the data in more parsimonious form" (Simon 1973, p. 479). For Gerald Weinberg science can only proceed by simplification: "Newton's genius was … his ability to simplify, idealize, and streamline the world so that it became, in some measure, tractable to the brains of perfectly ordinary men" (Weinberg 1972/1991, p. 505). Therefore, laws are not only convenient and economical, they are indispensable for scientific thinking. This idea cumulates in Ross Ashby's claim, "The systems theorist of the future, I suggest, must be an expert in how to simplify" (Ashby 1964/1991, p. 510).[2]

However one has to proceed carefully with the idea of compression of experiences into laws. For example the physicist Roman Sexl (1983) could prove that the hollow earth theory forms a complete alternative physical theory when applying certain formal inversions to conventional Newtonian physics. Both theories – living on the surface of planet Earth and living on its inside – may appear to be in extreme opposition to each other but both can be reconciled with physical data obtained in experiments. Therefore the hollow earth theory is a coherent scientific world view. In a sense, it is a mathematically equivalent version of our usual world view. Both can be mapped onto each other. It is up to the metaphysical criteria of science to decide which of them is "truer" than the other. Such criteria include simplicity, clarity, and beauty (McAllister 1996), which strictly speaking have nothing to do with the physical experiments forming the basis of either theory. In philosophy of science this is known as the empirical underdeterminism of theories, which says that there is an asymmetry between observable facts (which can be described in propositions) and postulated laws. As Pierre Duhem (1906) claimed, there is a practically infinite number of possible laws that can be extracted from a given data set. Starting from Glasersfeld's assumption that knowledge can be characterized as the isolation of repetitive patterns from the totality of sense data, the underdeterminism of theories lets us arrive at the conclusion that there must be an infinite number of possible meaningful entities that can be constructed from the stream of experience. Glasersfeld notes, "[t]here may, indeed, be countless ways of operating and arriving at coherent structures that are no less recurrently imposable on our stream of experience than the ones we have come to construct." (Glasersfeld 1974/2007, p. 82).

In view of the underdeterminism of laws, we face the question of the origins of the order that we observe in our reality. Let us first explore the traditional account according to which order comes from the "outside."

EXTERNAL ORDER

One of the central assumptions of naturalism is that the world is structured. Even constructivists like Gerhard Roth assure us that "of course, nobody has serious doubts about the fact that the brain- and consciousness-independent world is ordered" (Roth 1996, p. 365, my translation).

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[2] I am grateful to Ranulph Glanville for drawing my attention to Weinberg and Ashby.

This genuinely metaphysical assumption about the inherent ontological structure at the basis of (scientific) data sets has been challenged, among others, by James McAllister. He claims that "[a]ny given data set can be interpreted as the sum of any conceivable pattern and a certain noise level. In other words, there are infinitely many descriptions of any data set as 'Pattern *A* + noise at *m* percent', 'Pattern *B* + noise at *n* percent', and so on, ranging over all conceivable patterns" (McAllister 1997, pp. 219–220. (Here, the notion "noise" refers, in an information-theoretical sense, to the purely mathematical discrepancy between a certain pattern and a given data set.) Therefore all laws and patterns that can be read into a data set have the same status, which means that all of them match the structures of the "world" to the same degree. The statement that the world encompasses all possible structures is equivalent to the claim that it does not contain any structure and is, therefore, amorphous, i.e., structureless (McAllister 1999).

However, if the world is amorphous doesn't this mean that all scientists (can) do is cut out arbitrarily sized clusters of phenomena from a given collection of sense data? McAllister, too, points at this matter of fact. He writes, "a scientific law or theory provides an algorithmic compression not of a data set in its entirety … but only of a regularity that constitutes a component of the data set and that the scientist picks out in the data" (McAllister 2003, p. 644). In this sense scientific laws are algorithmic compressions of regularities partially covering a given data set. These regularities – or patterns – are competing with each other (e.g., the traditional model and the hollow earth theory), and scientists must choose which pattern they prefer over the others.

How is this decision making carried out? How do scientists determine which observational features or experimental results are trustworthy and relevant evidence of the investigated phenomenon? For example, Johannes Kepler, facing a huge amount of observational data about the passage of planets in the sky, needed many years to choose the proper data that led him to the formulation of his first law of planetary movement, according to which, planets revolve around the sun on ellipses (rather than circles or any other geometrical shape Kepler had taken into consideration in those years). As soon as he had isolated the appropriate data sets the formulation of the law fell into place while before other data sets had obstructed the view on it. This can be shown in computer experiments, in which the program "Bacon" formulates Kepler's first law instantly from carefully prepared data (Langley et al. 1987).

As a result two problems emerge. Does the structurelessness postulated by McAllister mean that scientists select regularities in an arbitrary fashion? If this is the case, how can we account for non-arbitrariness that reaches beyond the fact that the world and the sense data are structureless? Even constructivists such as Gerhard Roth are skeptical because "no matter how well developed the constructive abilities of the brain are, it could not recognize regularities in the so-called primary sense data if the sense data were pure chaos and did not contain 'objective order'" (Roth 1992, my translation).

ARBITRARY LAWS?

Roth's pessimism opposes Glasersfeld's opinion according to which even in a completely chaotic world the subject *can* construct regularities and order (Glasersfeld 1984). To this end we do not need to assume external factors because "selective drives" for patterns in data sets can emerge spontaneously without external influence. This ability of cognitive systems to mechanically recognize arbitrary patterns in data sets can already be demonstrated in everyday life, where one encounters phenomena such as perceiving faces in clouds, shapes and persons in stellar constellations, and reading one's fortune from the leftover tea leaves.

In a more scientific setting, "superstitious perception" was studied by Gosselin & Schyns (2003). They presented test subjects with pictures that contain white noise, i.e., a static bit pattern that has equal energy at all spatial frequencies and does not correlate across trials such that the pictures are stimuli without coherent structures. The subjects were asked to distinguish between a smiling and a non-smiling face which was allegedly present on 50% of the pictures. Indeed, the subjects recognized the expected face, which can be interpreted as indication of the fact that they projected (i.e., partially correlated with) the anticipated pattern into their perception of the white noise. This suggests that the “selective drive”, which controls the recognition of apparent patterns has internal rather than external reasons. McAllister continues this line of thought and points at a solution for the problem of relevancy. “Some of these patterns are taken by investigators as corresponding to phenomena, not because they have intrinsic properties that other patterns lack, but because they play a particular role in the investigators’ thinking or theorizing.” (McAllister 1997, p. 224) Discussing their results, Gosselin et al. (2001), too, claim that it “is important to stress that this information did not originate from the signal, but from their memory”. How can this be accounted for?

INTERNAL ORDER

Since in the “stream of consciousness” (James 1890/1950) sensations and experiences are made and linked to each other over the course of time, cognition is a historistic process. (The emphasis on this dynamic-historistic component may be considered in sharp contrast to the mainstream definition of knowledge as justified true belief, which focuses on logical consistency and logical analysis rather than prolific problem solving capacities.) Construction complexes are historistic collections in which experiences are positively (i.e., they are supportive evidence for each other) or negatively (i.e., they contradict previously made experiences) related with each other. Consequently they form a network of hierarchical interdependencies (Riegler 2001b) whose components are mutually dependent; removing one component may change the context of another component. However, due to the mutual dependencies within the network its components must not be considered in isolation. For example, there is a close relationship between the concept of movement and wall. Realists reproach RC with the argument that there is no doubt about the existence of walls, hippos, and tables, because as soon as the constructivist wants to run his head against a brick wall he turns realist. However this argument confuses ontology with experience. As Siegfried Schmidt (quoted in Pörksen 2004, p. 134) pointed out, “For if I want to know whether this table exists, there already has to be a table in my experiential reality I can deal with. The question of whether this table exists or not is an assertion that neither adds to, nor subtracts from, existence.” This quote makes it clear that RC emphasizes the mutual reference of experiential content. As Mitterer (2001, my translation) characterized the constructivist position, “our conceptions of reality can only be compared with other concepts rather than with reality itself.” In other words, experiential reality is a “conceptual network that has proven appropriate, useful or ‘viable’ in the course of making experiences because it has repeatedly contributed to the successful surmounting of obstacles or to the conceptual ‘assimilation’ of complexes of experience” (Glasersfeld 1991a, my translation).

Since new experiences are continuously inserted into the existing experiential network the latter becomes canalized. In a first approximation this can be compared with an ever-expanding jigsaw puzzle. Each piece that has found a place where it fits locks in with its neighbors. By doing so, it also expands the puzzle’s border, which in turn enables the addition of further pieces. On the one hand, the more pieces that lock in, the larger the puzzle becomes and the more pieces can be attached. But on the other hand, the actual shape of the expanding border of the puzzle determines which sort of pieces can be attached next, which results in canalization.

In more general terms, canalization refers to the asymmetry and probability-based irreversibility of how experiential components are brought together. Systems, whether natural or artificial, are driven into a continuous complexification of their structure and dynamics caused by internalist rather than externalist mechanisms (Riegler 2001a). In a similar vein, research in the area of formal networks arrives at similar results. Since according to Glasersfeld (1989a, p. 135), RC is a model of the “active construction of viable conceptual networks”, I suggest linking RC with network research. In what follows I will review basic insights in this area and discuss their relevance for RC, which will make the previous narrative arguments more precise.

NETWORKS OF CONSTRUCTION

In his essay “The architecture of complexity”, Herbert Simon (1969) argues that hierarchical systems are characterized by stability and speed. Simon claims that stability does not require any teleological mechanism, i.e., no goal setting from the outside, no causa finalis in the sense of Aristotle, in order to account for directedness. It is the hierarchical composition of systems that introduces a direction, a goal that “is provided [...] by the stability of the complex forms, once these come into existence.” (Simon 1969, p. 203) In addition, the “time required for the evolution of a complex form from simple elements depends critically on the number and distribution of potential intermediate stable forms.” This means that an appropriate hierarchical distribution yields an enormous advantage. Simon’s well-known metaphor of the two watchmakers Tempus and Hora illustrates this matter of fact. Both watchmakers have to build clocks consisting of $n = 1000$ parts. Unfortunately, they are interrupted in their work at random moments with a given probability p, causing an unfinished clock to fall apart. Simple calculation shows that Hora’s strategy yields a tremendous advantage with regard to the number of completed watches compared to Tempus’ linear style of working. For Tempus, who tries to assemble each watch in one go, the probability of actually finishing one is $p_F = (1 - p)^n$. By contrast, Hora divides the design of a watch into subassemblies of $k = 10$ parts each so that in the worst case only 10 components fall apart. Therefore, for each watch he needs to put together 111 partial assemblies. This reduces his probability of completing a watch to $p_F = (1 - p)^k$. If we now assume an interruption probability of $p = 10^{-2}$ then Hora will produce watches about 4000 times faster than his colleague. Simon concluded that “hierarchic systems will evolve far more quickly than nonhierarchical systems of comparable size.” These aspects, stability and acceleration can be expected in experiential networks too, provided they are hierarchically structured.

While Simon’s arguments are based on theoretical considerations only, Stuart Kauffman (1993) went a step further and wrote computer programs that demonstrate that in arbitrarily large networks there is “order for free” (Kauffman (1995), i.e, an evolution towards self-canalization without influence from outside the network. His original intention was to model autocatalytic systems, i.e., the network of genes that forms the basis of cell development in living organisms. He started from the assumption that in such random Boolean networks, there are n nodes and for each node, k in- and outputs connected to other nodes. Experimenting with different parameter sets, he found that $k = 2$ networks have the following properties. The number of states in which the network can be, is 2^n but the number of different cycles the network can run through is only $\sqrt{n}$. (More recent works, e.g., Bilke and Sjunnesson (2002), claim an even simpler linear relationship resulting in an even smaller number). This means that despite the high number of nodes, its dynamic is limited to comparatively few patterns of activity. Applying this insight to constructivist experiential network, we can speculate that even if there are many experiential elements the number of trains of thought is rather low. It has been argued that the typical size of an expert’s knowledge covers about $n = 50000$ elements (cf. Chase and Simon’s 1973 estimation of a human expert’s number of “chunks”). Assuming that each chunk is connected to roughly two other chunks ($k = 2$) we arrive at the conclusion that thinking follows $\sqrt{50000} \approx 223$ different trajectories. So, irrespective of which experiential element a thought starts at, it will eventually end up in one of about 200 canalizations. This computational result provides hard evidence for the claim that in networks order need not come from the outside. Instead, it emerges from the properties of their internal dynamics. On the contrary, Kauffman noted that many variations of binary networks are even able to compensate for perturbations from the outside. Following Ashby (1952), Kauffman called their robust behavior “homeostatic stability”. It is also reminiscent of Maturana’s (1978) definition of structure-determined systems in which perturbations trigger state transitions but cannot determine their behavior.

The historistic aspect is taken into consideration by Barabási & Albert (1998) on scale-free networks. In contrast to classical and random Boolean networks with a constant number of nodes and unchangeable connections between nodes, the number of links in scale-free networks follows an exponential distribution. Consequently, most nodes have very few links while a very few nodes, so called “hubs”, are linked with most other nodes. The probability $p(k)$ that a node is connected to k other nodes is $p(k) \approx k^{-g}$

with g being a constant that varies in different contexts. (For example, on the world-wide web $g \approx 2.1$ for ingoing links and $g \approx 2.45$ for outgoing links). In extension to what has been said above regarding the jigsaw analogy, which assumes an even distribution of opportunities of attachment, scale-free networks display a preferential attachment of newly arriving nodes. The probability that a new sensation joins the network at node i with k links is $p_i(k) = k / \sum k_i$. For the network of experience this means that well-linked sensations are quicker to lay new connections than other, less connected sensations. Eventually a hierarchical order appears in these networks that is fairly resistant against influence and destruction. However, this stability is only warranted in those cases where the numerous badly connected nodes are affected. In other words, targeting the well-connected sensations that are well-embedded in the network and hence older than others may severely disrupt the network. We consider this a confirmation of what has been said about the different degrees of accessibility (and hence changeability) in the network of experience. In fact, the old complexes referring to "objects" run deeper than mere "habits of thoughts" as their removal would turn the organization of the network upside-down.

Besides their hierarchical structure, networks of experiences must be arranged in a way that allows for the quick and direct association of experiences. Watts and Strogatz (1998; Strogatz 2002) showed that even in very large networks, links can be very short on average. They started from highly ordered networks that are characterized by a high clustering coefficient c, i.e., the probability that when two nodes, A and B, both have links to a third node C they are also directly linked with each other, $c = p(\text{A} - \text{B})$. In highly ordered networks c approaches 1 while in random networks $c = k / n$, i.e., it converges toward 0 in the case of big networks with many nodes. If the links in highly ordered networks are randomly exchanged, a small-world network emerges that keeps the advantageous characteristic of a high clustering coefficient but also inherits the property that is typical of random networks, i.e., a slowly (logarithmically) increasing diameter. In other words, the characteristic path length L between nodes in small-world networks is drastically smaller, $L_s = \log n / \log k$, than in highly order ones, $L_o = n / 2 \cdot (k + 1)$. (For example in a network as large as the human social network on Earth with $n = 6 \cdot 10^9$ the average distance of acquaintance between two arbitrary people is just $L = 6$.)

This review of the intrinsic properties of networks allows us now to amend the basic principles of RC and move them from mere narrative descriptions to more precisely defined postulates.

BASIC CLAIMS OF RADICAL CONSTRUCTIVISM

Glasersfeld (1989b) defines RC in terms of two principles. He maintains that knowledge is not passively received but actively built up by the cognizing subject. This he refers to as the "first principle of radical constructivism" (G1). Furthermore the function of cognition is adaptive; it serves the organization of the experiential world, not the discovery of ontological reality ("second principle", G2). He calls his constructivism "radical" because reality construction is ubiquitous. Consequently, constructivism has to be applied to all levels of description. "Those who ... do not explicitly give up the notion that our conceptual constructions can or should in some way represent an independent, 'objective' reality, are still caught up in the traditional theory of knowledge" (Glasersfeld 1991b, p.16).

From the common-sense perspective of narrative philosophy, Glasersfeld's principles could easily be misunderstood as postmodernist speculation, as an intellectual silliness that eventually leads into solipsism. What is needed here is an account of how the construction of knowledge can be achieved by the subject, how order from the "inside" comes about. As pointed out in the previous chapter, a series of formal considerations, mathematical and computer models can be used to accomplish just that.[3] Note that

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[3] Emphasizing mathematical and computational methods in no way implies giving them *epistemological* precedence over narrative methods. Like doodling and sketching in architecture (Glanville 2006), which offer convenient *visual* shortcuts for reasoning, formal methods are *pragmatic* shortcuts providing a "quick and convenient way of getting

the notion "inside" itself is problematic. G1 suggests that there is an "insurmountable border" around the cognizing subject which, very literally, defines the limits of his or her world. Assuming such a boundary has lead to distinguishing between "wirklichkeit" and "reality" (Stadler & Kruse 1990). Deriving from the German verb "wirken" (to have an effect) the former expression refers to the world of experiences in the sense of Glasersfeld, while the latter is linked with the realm of "ontologically given things", i.e., "objective reality." However, talking about "reality" is metaphysical speculation; following Glasersfeld's skeptical argument there is no way to verify our perceptions other than through the senses through which we made the perceptions in the first place. "Reality" could be anything, either it is indeed as we think it is, or it is the hollow Earth scenario, or it is entirely amorphous. However, ultimately this is irrelevant to the extent that the network of experiences creates its own order based on its inherent properties. In this sense Glasersfeld's G2, demanding the organization of experiences, receives the necessary precision in terms of formal network models.

Ultimately, Glasersfeld's two principles can be extended to four postulates (for further details see, e.g., Riegler 2001b). P1 describes RC as an approach focusing on organizationally closed systems, i.e., systems which can be characterized as networks with hierarchically arranged components of short characteristic path lengths between them and a high clustering coefficient. P2 defines the agnostic perspective with regard to an "external/objective" reality: whether or not the world is amorphous is left to speculation. There is no need to assume external order parameters as order arises from within the system. P3 emphasizes the circularity of the trains of thoughts, i.e., that experiential components are linked with each other thus forming a network of relations. Trains of thoughts can be described in terms of state cycles in the network. P4 demands that reality construction in such systems is limited rather than arbitrary. The limitation arises from inherent properties of the hierarchical network.

Given that network models (a) need no empirical support and therefore no biologism nor naturalism, (b) forgo arbitrariness, and (c) go beyond narrative (armchair) philosophy due to their demand for formal precision, we are ready to draw some general conclusions for an extended version of radical constructivism.

CONCLUSIONS

From the arguments presented in this thesis at least three conclusions can be drawn. (1) RC is no naturalism in general nor a biologism in particular. Wendel (1992) argued that starting from empirical grounds (such as the neurophysiological insight of the unspecificity of nervous signals) RC climbs Wittgensteinian ladders to arrive at epistemological insights that disprove the validity of the very same empirical findings. In this paper I positioned RC close to formal grounds, such as network theories, which make this criticism superfluous. The basic elements of RC – closure and self-construction – are qualities that can be accounted for in terms of formal networks. Even if we assumed that the world is entirely amorphous, RC would not lose anything of its potential. By contrast, naturalists start from the assumption that there is an ontologically given order in the world, which science has to detect or at least reconstruct; (2) RC does not support the idea of arbitrariness nor an "anything goes" attitude in science. Since in RC knowledge is characterized as the construction of viable and coherent conceptual structures in terms of networks, and since in networks canalization and, consequently, order appears without external parameters, constructions cannot be arbitrary. Glasersfeld's (1987) claim that constructions are limited to trial and error needs to be extended to encompass canalization generated by the cognitive system. Reality construction, therefore, transcends randomness and "black box" viability. (3) Even though RC feeds on certain philosophical traditions (such as skepticism and instrumentalism, among others), it rises above them by leaving behind conventional narrative and analytical philosophy (which is based on static-logical

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from place to place, like a subway" (Heinz von Foerster, as quoted by Glanville, personal communication). They are indispensable simplifications for advances in scientific reasoning (Weinberg 1971/1991; Riegler 1998).

propositions) and turns into a dynamical computational epistemology (cf. Thagard's 1998 approach of computational philosophy). This is indispensable for working with network models. It is "the precision and completeness that is required to build a working system" (Darden 1997) that boosts the computational method, since the "philosopher-historian may neglect aspects that the programmer must specify in detail if the system is to run" (ibid). By focusing on computational network models, RC is not only in a position to comply with this imperative, it also poses an intellectually demanding challenge that is far from capricious silliness.

NOTE

This is the revised English translation of the paper "Der Radikale Konstruktivismus als erneuernde Philosophie: Gegen Naturalismus und 'Anything Goes'" that will appear in Rusch, G. (ed.) Neuer Konstruktivismus. Carl Auer: Heidelberg.

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