parentheses around "objectivity" represent awareness – that special awareness that we, in order to validate our explanations, are unable to refer to or reference anything (neither a thing nor a logic) that is independent of us. Plus an awareness of the fact that our explanations are validated by coherence in the logic of our experiences: "In fact, scientific explanations do not explain an independent world, they explain the experience of the observer" (Maturana 1988: 38).

« 9 » By being aware that we explain the logic of our experience through the logic of our experiences, we notice that there are numerous domains of explanation because each domain of coherent experiences represents a domain of explanation: in this domain, we can draw on experiences within it in order to explain other experiences from it. And since each of these domains of explanation is experienced as a domain of objects or as an area of reality, this explanatory path gives rise to numerous realities, even if the physical reality remains one. This is because they are "realities for me" and not absolute realities. But how could we make this step and reach the awareness mentioned by Maturana?

Ceccato's "Theory of Attention"

« 10 » Something that could help us become more aware of our construction of reality is, for example, Ceccato's "Theory of Attention,"[7] inspired by Percy Bridgman's operationalism.[8] His "operational idea" was the starting point for a development in theory that led to approaching concepts as operations (operational analysis of concepts), one of the core thoughts behind radical constructivism. Physicist Bridgman discovered that the problem of simultaneity in Einstein's theory of relativity can be elegantly resolved by defining the concept of simultaneity by means of operations. This approach from physics also fitted perfectly with Ceccato's idea that we construct concepts through mental operations (Ceccato 1947): Ceccato started to devise an analysis of concepts that could identify the mental operations needed to generate a concept.

« 11 » According to Ceccato's theory, the actual fundamental conceptual operations are not physical actions, as in physics, but rather "moments" or "states" of attention. Attention is usually presented in psychology or common sense as a kind of spotlight that illuminates something. In the case of Ceccato, attention is a much more comprehensive function (an attentional system or organ), which has a special "constitutive" and also "regulative" impact rather than being purely image-based: the operations of attention determine the object as far as its logic is concerned, and not the other way around. Attention is the mechanism by means of which we create our constructs, our reality; the *How* (attentional operations) determines the *What* (our reality), as far as its logic is concerned.

« 12 » The functionality of this proposed attention organ, which I call the "categoriser," is derived from a pulsating fundamental notion: the categoriser produces an uninterrupted and even rhythm of ("conscious") moments or states, rather like our breathing and circulation. Experiments in neuroscience have indirectly confirmed this approach on several occasions (Harter 1967; Lehmann et al. 1998). Dietrich Lehmann and his research group in Zürich, for example, have devised experimental results that suggest that "the seemingly continuous stream of consciousness consists of separable building blocks." These attentional blocks or moments serve as building blocks in the construction of more complex units (Bettoni 1989: 13). Through mental operations (so-called "categorising"), we construct these units using the categoriser, combining the moments with one another (free moments) and with the functioning of other organs, e.g., sensory impulses i.e., the eyes, ears, etc. (focalised moments). Ceccato gave the name of "mental categories" to these connections between free moments of attention, in honour of Kant (Ceccato & Zonta 1980: 53). Examples include pure terms such as "something," "object," "and," "or," "with," "singular," "start," "end," "element," "point," "true" and "energy," etc. Examples of connections from focalised moments are "hard," "water," "horse," "melon," "paper," "pencil," "cat," "guitar" and "sun," etc.

« 13 » In §28 Füllsack mentions the focus of European epistemology on substances and objects rather than on "processes that bring them about." This seems to be a good place to link with Ceccato's theory of attentional operations; but the focus must be on a *functional* level, not on the recursive processes mentioned in the article, because these belong merely to the *implementation* level.

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The Construction of the Environment

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> Upshot • The environment is not slowly constructed by the agent but is an integral part of being an agent because both, agent and environment, are part of a closed loop system. By identifying the perturbations impacting on the loops, with the help of second-order cybernetics, the agent can identify them as its environment.

« 1 » My main criticism of this article is the establishment of the environment (see §§ 24 and 25). In the classical constructivist tradition there is, of course, no "real" environment and it needs to be constructed. Through the interaction with "something," we construct the environment. In my initial review, I dared to say "real environment" and the author rightfully reminded me of the dispensable nature of the "real world" in constructivism. I am now going to describe

7| A brief description of this theory can be found in Foerster & Glasersfeld (1999: 49ff).

8| Heinz von Foerster, Ernst von Glasersfeld and Ceccato explicitly considered Bridgman to be a sort of "enlightenment" (Foerster & Glasersfeld 1999: 45).

in greater detail my definition of the "environment" and why the target paper is not radical enough when defining it.

« 2 » What is environment? Clearly it needs to be different to the agent (Alrøe & Noe 2012)? How to avoid being branded a naive realist when talking about this "something" called environment that seems to be somewhere? Like AI, or biologically inspired robotics too, constructivist theory has "a grounding problem" in that it bases itself on – constructivism. So, what is one allowed to say before one faces getting thrown into the unmarked space of the non-constructivist limbo?

« 3 » From my point of view, there are two main aspects:

1 | At the center of the constructivist paradigm are closed loops. This means that there is no input to or output from these loops. Agent and environment are indistinguishable. The agent is agent and environment at the same time. Even control engineers oblivious of constructivist theory know that one can describe the plant and the controller with the same math, and it is possible to absorb the plant into the controller and vice versa. This is what Heinz von Foerster calls the "principle of undifferentiated encoding": "The response of a nerve cell does not encode the physical nature of the agents that caused its response. Encoded is only 'how much' at this point on my body, but not 'what'" (Foerster 2003: 214f). Niklas Luhmann calls it "elements" (e.g., communications create communications, etc., Luhmann 1995). In this way, there is no construction of an environment but constructions of new loops.

2 | The reason why we construct loops is because of perturbations we need to act against. These perturbations originate from the environment but at this point cannot be identified by the closed loop system. I would even argue that for the agent, perturbations *are* the environment (Porr & Wörgötter 2005). In order to find out that new loops have been developed, the agent needs to develop even more loops to observe the other ones, which is called "second-order cybernetics" (Foerster 2003: 285). How is the agent able to find out what is environment or how to "construct" it? It observes the perturbations acting on loops with the help of other loops and calls them environment. This is, for me, in a nutshell the constructivist paradigm.

« 4 » Now, in his article Manfred Füllsack claims that digital computers have a grounding problem. I would argue that there is no problem with them at all as long as the following three criteria are met, as mentioned above:

1 | A computer needs to run in a closed loop, for example a robot's actions need to feed back to its sensors, and so on. Perturbations arise in the electronics, or in the environment (for example, obstacles, food, attacks, other agents, etc.)

2 | The robot needs a mechanism to develop new loops, for example for predicting perturbations so that it is able to observe with these loops the previously created loops. This can easily be done by closed loop learning (Porr & Wörgötter 2006), which controls desired states and tries to predict perturbations in other loops.

3 | Once the prediction of perturbations has been established, the robot can identify them as environment, be they food or another agent, in the sense of Luhmann's double contingency.

« 5 » Therefore, the problem in this article is that environment is not clearly defined and is just introduced as "something" that needs to be constructed but outside of the agent. It appears that the agent is first created as an entity and then slowly "constructs" its environment while interacting with it. The approach needs to be more radical. The agent and the environment are one entity forming a closed loop from the outset. The environment is not a fuzzy entity at the beginning that then gains shape, but is rather as solid as the agent from the beginning. Coming back to von Foerster: the central heating works from the outset; it has a construction of the weather in terms of a maximum boiler power, which in turn represents the requisite variety of the loop dictated by the environment. It could be improved by adding more control loops that improve the first one through learning. The same applies to an animal that can successfully escape from a predator. Here, its maximum muscle strength and its strategies to run and then hide are its constructions of the environment and can be improved by observing its environment while it is escaping or on reflection. On the level of social systems, one could, for example, think of the financial system, where a sudden loss in profit requires a company to adjust where its construction of its environment takes into account the factors that impact on their internal operations, factors such as changes in customer behavior or the rise of a competitor. Again, the environment was part of the loop from the outset because a company can only run its self-referential operations when its loops are working from the very beginning. Coming back to the digital computer: it can act both as the agent and as the environment as long as we obey the rules set out above and we accept that the loops we create model the loops in animals that have been created by evolution. However, these could be created with the help of genetic algorithms that select agents that have working loops, for example the agents that can escape a predator or can find food. In the end, this is how Humberto Maturana founded his constructivist approach, namely requiring stable, self-referential systems (i.e., with attractors) that are able to maintain their self-referentiality throughout their life. For example proteins produce proteins and so on in a self referential cycle and they do not diffuse into the ocean, which essentially means that they should not die.

« 6 » In summary, I find that the article is not radical enough in how environment is introduced. Environment and agent represent one unit forming a closed loop. The agent needs to tease out what is environment and what is agent by observing perturbations acting on the closed loops to identify the environment, which is essentially the source of perturbations.

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