Author's Response

Further Reflections on Maturana's Key Insights

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> Abstract • In response to the many interesting points raised by the commentators, I discuss Maturana's "circularities of speech," the importance of metabolism, the absence of cognition in chemical autopoiesis, the semantics of "mind" and "consciousness," and the central issue of whether the Santiago theory overcomes the Cartesian dualism of mind and body.

« 1 » The main purpose of my target article was to give a succinct overview of the principal insights developed in Humberto Maturana's work, emphasizing especially the exact chronological sequence, the differences between Maturana's ideas before and after his collaboration with Varela, and related ideas by other scientists at the time (Gregory Bateson, Ilya Prigogine, and Geoffrey Chew). I was very pleased to see that most commentators feel that I have succeeded in this task.

« 2 » In reviewing Maturana's key insights, I concentrated on his work during the late 1960s, 1970s, and early 1980s, which, in my opinion, has had the greatest impact on the systemic understanding of life that has emerged during the last forty years. Several commentators (Alejandro Ochoa-Arias, Bruno Jerardino-Wiesenborn & Alberto Paucar-Caceres, Pier Luigi Luisi, and Mario Villalobos) discuss Maturana's elaborations during later decades, which sometimes contradicted his earlier work (e.g., in his modified view of structural coupling, as pointed out by Villalobos) but which offer exciting opportunities for further discussions and research. I must admit that I am not as knowledgeable about Maturana's later work as these commentators, and therefore not able to respond to their points, except to say that Maturana's writings in the 1990s and 2000s, much of them in collaboration with Dávila Yáñez, seem to me increasingly further away from his early scientific work on color vision and neurophysiology. So, while I find Ochoa-Arias, Jerardino-Wiesenborn & Paucar-Caceres's motivation to complement and enhance the target article admirable, as they bring in Maturana's later work on an "onto-epistemological framework," I cannot usefully comment on points that refer exclusively to Maturana's later writings.

« 3 » Speaking of the rather philosophical side of Maturana's work, Fred Cummins draws attention to Mahayana Buddhism in connection with *The Embodied Mind* (Varela, Thompson & Rosch 1991) and later works by Evan Thompson and others. I found their discussion very apt, having been interested in the parallels between modern science and Buddhism for many decades. Luisi and I specifically discussed the affinity of Buddhist philosophy with the systemic conception of life (Capra & Luisi 2014: 289f). However, I do not know of any direct influence of Buddhist philosophy on Maturana's thought.

« 4 » To the best of my knowledge, the exact sequence and nature of Maturana's many deep insights have not been documented before, and I feel that a clear account of his achievements is also of value because his writings are often difficult to understand. Vincent Kenny (§16) commented on Maturana's "circularities of speech" in which he tried to mirror the circularity of the "organization of the living." I have always felt that another reason for Maturana's frequent repetitions and redundancies was his attempt to embody in his language the consistency inherent in mathematics. He was known to dislike mathematics and instead attempted to achieve linguistic precision and consistency. "A formalization," he wrote, "could only come after a complete linguistic description" (Maturana 1980: xvii). As a result, his publications often read like an elaborate legal brief rather than a concise scientific argument.

« 5 » Kenny, by the way, argues that the term "insight" implies some observer-independent entity and should therefore be avoided (§15). In my view, it is not necessary to repeat the constructivist position every time one uses words like that. Once we understand that the way we distinguish between "objects," "patterns" and "processes" is brought forth collectively in language, we can continue to use these words (as well as references to "discoveries" or "insights") without creating confusion. The situation reminds me of a Zen saying:

> "Before one studies Zen, mountains are mountains and rivers are rivers; while one studies Zen, mountains are no longer mountains and rivers are no longer rivers; after enlightenment, mountains are once again mountains and rivers once again rivers." (Reproduced in my *The Tao of Physics* 1975: 126)

« 6 » Kenny Q1 observed that some of Maturana's notions might even be taken as tautologies, and he wondered whether this was applied to the definition of cognition as a system's ability to survive in a medium. I do not think so, because the need of living systems to continually interact with, and respond to, changing metabolic flows from their environment in order to stay alive is far from trivial. In an interview, Francisco Varela put it very clearly: "The fundamental part of mental phenomena simply comes from our ability to move around in the world."[1]

« 7 » Kenny Q2 also wondered whether an organizationally closed system would not exist *unchanging*, and could therefore not be "self-organizing." This is an important point, acknowledged but not discussed in detail by Maturana. Living systems are both open and closed. They are operationally closed (autopoietic bounded networks) but energetically and materially open (i.e., open to continual metabolic flows). Their openness in changing environments results in continual structural changes through structural coupling. Maturana emphasizes that this is an "autonomous" response of the system, which specifies "its own laws," and, as I pointed out in §11, this self-referring nature of systems corresponds to what is often referred to as "self-organization."

« 8 » In this context I would like to mention that even if it does not directly relate to my target article, I found Cummins's discussion of the use of "organism" and, more specifically, of the terms "human" and "animal" within the embodiment literature enlightening. The continuing reassessment of properties once considered as uniquely

1 "Interview: Francisco Varela & Eric Goles," Santiago, May 2000, translated and subtitled by Keven Poulin, https://www.youtube.com/watch?v=wh7_rxARhJc at position 22:25.

human is indeed striking, and it underlines once more the importance of Maturana's sophisticated apoproach to human language (Maturana & Varela 1987: 245f).

« 9 » At the end of my article, I suggest that one should consider extending the concept of autopoiesis from the molecular to the cellular, social, ecological, and planetary levels. Ochoa-Arias, Jerardino-Wiesenborn & Paucar-Caceres support my suggestion. They also cite several attempts to do so, which I find very rewarding. However, any detailed treatment of their proposals would go beyond the limits of my response. By contrast, Luisi has gone in the opposite direction, investigating the conditions for "minimal life" in the laboratory with synthetic models of chemical autopoiesis. In §8 of his commentary, Luisi reported that the synthetic systems studied so far are autopoietic but not cognitive systems. I find this an intriguing challenge to the Santiago theory. As pointed out in §41, cognition is the dynamics of structural coupling. A structurally coupled system is a cognitive system. Maturana and Varela (1980: 74), as distinguished from Maturana alone in his earlier work, present structural coupling as an integral feature of autopoiesis. Thus, in their view, an autopoietic system is a cognitive system. If synthetic systems with "chemical autopoiesis" are not cognitive, this would mean that they do not couple structurally to their environment. Another way of saying this would be to say that such synthetic systems lack a sensory apparatus. To use an old philosophical term, they are not "sentient beings." In that case, it might be useful to qualify this type of "autopoiesis without cognition" to distinguish it from the phenomenon in the full-fledged living cell, described by Maturana and Varela.

« 10 » A central issue in the commentaries by Urban Kordeš (§2ff) and by Villalobos (§7) is my claim that the Santiago theory overcomes the Cartesian dualism of mind and body. Both commentators point out that whether or not this claim is justified depends on what we mean by "mind." The semantics of "mind" and "consciousness" are notoriously muddled. Maturana, at least in his earlier work, studiously avoided the term "mind." While, as far as I know, he was never explicit about it, one might assume that in view of its Cartesian association with a "thing," he considered the term inappropriate for describing the process of cognition. Bateson (1979: 92), too, was aware of this dilemma. He used both "mind" and "mental process," but always emphasized that "mind" stands for a set of mental processes.

« 11 » In my own writings, I have used "mind" and "cognition" synonymously, but generally preferring Maturana's term "cognition." As emphasized in §47, I see the relationship between mind and body (and, specifically, between mind and brain) as one between (cognitive) process and (biological) structure. In his interview (see Footnote 1), Varela illustrated this with a very nice analogy:

> "To say that there is some contradiction between the mind and the body would be the same as to say that there is a contradiction between the movement of a horse and its legs. That's absurd! […] It's the same with the brain [operating] inside the body […]. When all the parts become active, like the legs of a horse, we have a phenomenon that emerges – not a movement but the mind."

« 12 » I have also been very careful to clearly distinguish between cognition and consciousness (but I did not go into this in the article). Cognition, as understood in the Santiago theory, is associated with all levels of life and is thus a much broader phenomenon than consciousness. Consciousness – i.e., conscious, self-aware, lived experience – unfolds at certain levels of cognitive complexity that require a brain and an elaborate nervous system. When and how exactly consciousness emerges as a special form of cognition is still not understood. This is the "hard problem" of consciousness research.

« 13 » To summarize, if "mind" is used synonymously with "cognition," I feel confident that the Cartesian duality between mind and body has been overcome in the Santiago theory. However, if "mind" is used synonymously with "consciousness," we still have a long way to go to solve the hard problem. As I have argued elsewhere (Capra & Luisi 2014: 257ff), significant progress toward this goal has been made by Varela (1996) in an approach he called "neurophenomenology," which combines the disciplined examination of conscious experience with the analysis of corresponding neural patterns and processes; and by Antonio Damasio (1999), with a detailed account of the roots of consciousness in biological processes. So, there is no doubt that Maturana's work on consciousness was carried forward by Varela. However, while Maturana's work on this topic was certainly incomplete, so was Varela's. The hard problem is still with us.

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