Journal of
Sociocybenetics

Journal of Sociocybernetics ISSN 1607-86667

ORIGINAL ARTICLE

Rolando García's "Complex Systems Theory" and its relevance to sociocybernetics

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Complex Systems Theory ("TSC" for its Spanish acronym) by the Argentine-Mexican physicist and epistemologist Rolando García (1919-2012) provides a comprehensive framework to approach complex issues or complex problems requiring an interdisciplinary approach. In this work its theoretical and conceptual framework is summarized and exemplified through case studies. TSC proposed methodology and constructivist epistemology are also briefly introduced. Furthermore, its relevance for sociocybernetic is discussed on a programmatic level.

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Introduction

The Complex Systems Theory ("TSC" for its Spanish acronym) by the Argentine-Mexican physicist and epistemologist Rolando García (1919-2012) provides a comprehensive framework to approach complex issues or complex problems requiring an interdisciplinary approach (García, 1986, 2000, 2006). The TSC includes: (i) methodological guidelines guiding the integration of disciplinary inputs based on collaborative modeling, (ii) constructivist epistemology, and (iii) a succinct theoretical frame that provides a conceptual language and general principles to analyze the issue.

By "complex issues" we understand situations, phenomena, and critical behaviors with fuzzy boundaries and complicated dynamics requiring urgent intervention of different multi-disciplinary teams, especially those including scientists interested in real interdisciplinary research. The TSC proposes a cognitive organization of a slice of reality that requires understanding complex and dynamic mechanisms to explain how it works (Duval, 1999).

Some of the "complex issues" that have been analyzed under the complex systems approach —with different elaboration levels— are: climate change and famine (García & Escudero, 1982; García, 1984, 1988), eco-sustainability (Ortiz Espejel, 2005), environmental degradation (Castañares Maddox, 2009), educational problems (Amozurrutia, 2012), urban marginalization (Sidorova, Carranza, Karina, & Pérez, 2013), productive and technological development (N. Becerra, Baldatti, & Pedace, 1997), among others.

We hereby focus on the rudiments of the TSC's theoretical and conceptual framework, with just brief references to the theory's epistemological foundation and methodological guidelines. It is of our

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interest to highlight how significant the TSC could be to sociocybernetics. García's work has had a strong impact in Latin America, serving as the knowledge base for several interdisciplinary research groups' work, some of them —such as the LabCOMplex one (Amozurrutia & Maass Moreno, 2013)— with growing presence in the International Sociological Association's Research Committee (#51 "Sociocybernetics"), although there are no summarized presentations in languages other than Spanish. We expect this work will allow an improved interchange between Latin American researchers and those from other geographical areas devoted to complex issues.

This work is comprised as follows: (#1) we introduce a basic definition of the notions of "complex system", "empirical complex", and "interdiscipline" together with basic methodological and epistemological components; (#2) we introduce the main concepts from the systemic approach with empirical work examples, and some comments about the approach's links to other contemporary scientific developments; and, finally, (#3) we propose some brief and programmatic notes about the theory's relevance to the sociocybernetic approach.

#1. Definition and interdisciplinary construction of a complex system

The TSC understands the concept of "system" as to the representation (or cognitive organization) of phenomena and situations with multiple components where different interdefinable processes converge (García, 2006, p. 21). This definition aims at highlighting the fact that systems are not a given but are built (conceptually) through observation and linking. Complex systems intend to represent issues that go beyond a certain discipline scope (such as the social, biological or physical systems), and thus requiring to integrate different disciplines' view.

The idea of "complexity" appears as an adjective or attribute ascribed within a cognitive relationship: something (as object of knowledge) is complex to someone (as subject of knowledge). By focusing on the relational and cognitive aspect of the complexity, this definition has the advantage of not treating a complexity as "inherent" to an entity independent from the subject of knowledge, as it could be inferred from the more abstract question "What is complexity?" (García, 2000, p. 67). Instead, this "relational" complexity is associated to the subject of knowledge's ability to interact with the elements and relationships within the system, so that when the subject's abilities change the perceived system complexity sought to be unveiled also changes.

The complexity of elements and processes within complex systems rely on the interdefinability of its heterogeneous elements. When referring to "interdefinability" we mean the mutual reliance of the functions and attributes of elements as well as the system they are part of. They are not relationships of mutual causality between two elements but, as sociologist Pablo González Casanova (2004) underlined, they are synergistic and contradictory, dialogic and dialectic, functional and dysfunctional, articulated and complicated relationships.

Due to this interdefinability of its elements, the system works as an "organized relative totality". It is a "relative" totality for all of the attributes and relationships are not intended to be analyzed but only those that are more relevant in specific scenarios (Amozurrutia, 2012, p. 58). The analysis of this relative totality is focused on its organization, i.e., on the way the elements are related rather than the presence/absence of specified elements. It is only upon a certain organization that the system shows certain attributes (qualities not present in stand-alone elements or vice versa), such as vulnerability, stability, diversity, resilience or regenerability, and even evolutionary behaviors.

The system's interdefinability of elements and the way it behaves as an organized totality are an obstacle for both isolated or sectored studies aiming at "breaking up" the system into pieces, such as the ones that intend to rebuild totality by "simple addition" of its elements. "Complex systems" match up to what Herbet Simon (1962) calls "nearly-decomposable" systems and it is what García takes as an essential feature when conceptualizing about social complex systems.

This poses an epistemological challenge to complex systems studies: the interdefinable elements within the system extend to "material domains" from different disciplines. These elements are, in this regard, "heterogeneous", and to integrate them, both concepts and observables, makes us face new challenges. It is important to note that García takes the notion of "material domain" from Jean Piaget (1979), who used it to refer to the set of objects that a specific science ponders by means of a "conceptual domain" of its own. In other words, situations and processes referred by complex systems do not correspond with the explanatory and/or empirical grounds of any particular discipline but tend to go beyond via an interdisciplinary outlook proposing a dialectics of differentiation and integration (García, 1990). The elements' heterogeneity is a necessary condition to talk about a complex system but it is not sufficient. Additionally, even though all complex systems are complicated or compound, the inverse relationship is not valid. Going back to the definition of "complexity" associated to the relationship between the object of study and the subject of study's abilities (now: disciplinary guidelines), what is brought into discussion is the TSC's difficulty to create an interdisciplinary approach to integrate the aspects from areas other than the scientific arena and which are considered to be non-dissociable to understand and transform the issue.

In accordance with the above introduced definition, a complex system can only come up in the course of an interdisciplinary research study. For the TSC, "interdiscipline" is a methodology seeking to get an integrated analysis of processes within a complex system which accounts for the system's behavior and development as a "partially organized totality". "Methodology" here is thought as a course of action in a research setting drawn from the theory of complex systems and which is in accordance with its constructivist and epistemological grounds.

Before we go on, we must make another distinction regarding the "complexity" notion, now taken as a noun: the "empirical complex". This notion refers to the set of empirical records and previous studies researchers have been able to collect, do, make or select to analyze to try to illustrate an issue from the real world. Sectioning the empirical complex is the first step to build the complex system. The following is required to do so (García, 1984, pp. 17–21):

1. To define certain basic questions guiding the search for empirical information.

2. These questions will allow setting the scope of some phenomena and typical characteristics illustrating the issue and which will become a common object to inquire into different interpretative frameworks.

3. To identify certain observables and observables-based inferences.

Constructing an empirical complex brings about the first "slice" of reality. García adheres to Goldmann (1972, p. 75), who states that "social reality is too rich and too complex for all of the given data to be able to be analyzed". Note that the adjective "empirical" applied to the data making up the complex does not mean "originated in pure experience" but to an experience originated in some level of development, especially a tentative theoretical schema from which the data is "constructed" (García, 2000, p. 197). It is a question then of focusing on those more significant aspects that allow to outline the issue as an object of knowledge with an apprehensible complexity. This involves reaching a first consensus among team members on what is to be searched. This consensus is not about theoretical, methodological or empirical criteria but about an approach outlined by the questions: Which side of reality do we experience as an issue? How do we want reality to be? It is evident that such questions stand as the team members' political viewpoint. That view refers to what is known as "epistemic framework" (García, 2000, 2006, p. 45; Piaget & García, 1982) in genetic-constructivist epistemology: a Weltanschauung, which is rooted in religious, philosophical and sociopolitical determinants, and which permeates and determines cognitive constructions regarding a time period and place, especially including the way the knowledge-society relationship is conceived.

Answering the same question coordinately and coherently is a requirement for the different disciplinary outlooks to integrate into a "complex system". The kind of interdisciplinary research the TSC pursues is defined by a joint mapping out and construction of an object of knowledge by a collaborative interchange of a multidisciplinary team, which is in line with what classical literature on interdiscipline calls "integrated interdisciplinarity" (Boden, 1990).

According to Amozurrutia (2012), the interdisciplinary work methodology within the TSC proposes aims at creating a second order reflection upon a complex issue. By "second order" or "second level observation" we mean the observation observing another observation, which allows recognizing latencies or blind spots (Foerster, 2003). In this connection, interdisciplinary research on complex systems seeks to work toward an ongoing and participatory analysis on the way the complex issue is observed. This dialog is expected to enable the convergence of standpoints and the creation of new avenues that would overcome the limitations of partial standpoints. Amozurrutia's proposed "adaptive model to analyze complex social issues" (2012) may help us illustrate the role computer modeling plays in interdisciplinary research on complex systems. It is our opinion that these techniques are most useful for providing a shared instrument to team members to explore different ways of recording, relating, and representing empirical complex data in different "scenarios" constructed by particular data configurations representing assessments and boundary conditions. The objective is to simulate some behaviors in the context of a "strong heuristic strategy that enables to create new avenues to get closer to solve the problem" (Amozurrutia, 2012, p. 44).

#2. Complex Systems Theory: Theoretical-conceptual framework

What makes the TSC theorization singular is it aims to organize phenomena across social, physical or natural domains, its functions and evolution as an organized totality. The TSC's conceptual lexicon comprises a set of systemic notions that we will herein go through, and which we will try to illustrate with pre-existing complex systems research studies.

#2.1. Boundaries, elements, subsystems, boundary conditions

The first concept is the boundary concept. A boundary establishes which elements (abstracted from the empirical complex) are considered an integral part of the system and which ones are their environments. It is well known that in real life an issue fails to have clear-cut boundaries. However, the system —understood as the conceptual representation of the issue— is dependent on the criteria used to construct an object of knowledge: it cannot be neither so broad as to avoid a slice (that is to say, it should refer to an apprehensible complexity) nor that narrow so as to leave other distinctive factors out (i.e., the slice arbitrariness should be reduced considering its centrality to the empirical complex) (García, 2006, p. 48). Ultimately, there is not a clear-cut division between relevant and irrelevant relationships but rather a continuum of degrees of relevance whose boundaries must be set by the research team (García, 1984, p. 36). This is why the system boundaries are rather tentative and provisional and are subject to continuous reviews throughout the course of the research study.

In many cases, these initial boundaries may refer to geographical borders of either a town or regional area where the social issue is identified. However, such decisions should be revised in view of more relevant dimensions: even though geographical borders usually determine the area of influence of some laws, they could be of lower relevance to handle other informal processes —such as the productive, economic, and, especially, cultural ones. For example, in a complex system research study on the marginalized youth in the Merida (Yucatán, Mexico) area, the city's geographical borders were established as the system boundaries because it was assumed that the young people's place of residence had a strong symbolic weight in the social stigmatization process (Sidorova et al., 2013).

The aggregate of the relationships among the system elements set up the system structure. Note that the systemic analysis focus is not on the existing elements (which at most would determine an "aggregate") but on the relationships among them. In fact, the same elements may belong to different structures based on which relationships are selected to analyze.

Let us repeat that "to construct a system" means to choose the elements abstracted from the (material) empirical complex, and to identify (i.e., to infer) a certain amount of relationships among such set of elements. The aggregate of relationships will comprise the system structure (García, 2000, p. 71).

As stated above, the relationships among elements are not directly observable but inferred, that is to say, they are the result of a research team's cognitive activity, together with their different interpretation frameworks, focused on the empirical complex material. In other words, for the cognitive systems theory, the relationships among elements are attributes and hypothetical constructions that must be substantiated afterwards rather than ontological properties of the object, with an actual existence independent from the subject of knowledge.

Given the fact that the system is made up by the selection of inferred relationships, all of the systems entail the adoption of an observation level that could either increase or decrease the relationships therein, thus resulting in a new system which is "at another level of study" (García, 2006, p. 50). A basic postulate from the systemic approach is observed: every system is made up of partial relationship subsystems while, at the same time, it is a constituent part of a bigger relationship system. In the individual case of the complex systems, the subsystems match "specific problematic areas" (García, 1988, p. 34) that can be apprehended through certain related disciplines or branches of knowledge. In this regard, that certain relationships prove to be "more significant" mean that they are selected because of their intelligibility in the light of previous studies, either correlated with empirical observables, methodological and theoretical approaches contributing with local explanations, or even specific controversies and discussions among works from related sciences. Such relationships are only possible when the observed phenomena —taken now as elements— remain in the same space-time scale. For example, a research study on the development of policies in agrotechnology and agroproductivity in the Argentine Pampas between 1943-1990 (N. Becerra et al., 1997) was based on an empirical complex with very heterogeneous data such as production levels of various crops, use of agricultural machinery, herbicide use, history of the different social groups, history of their confrontations and relationships, their legal and regulatory frameworks, soil efficiency levels, etc. By analyzing the interaction among these elements, the authors characterized a "pampean agricultural system" comprising a physical subsystem —water, soil, climate, ecosystems—, an economic and social subsystem —social groups, conditioning economic factors, political factors—, and an agricultural and productive subsystem —crops, production systems, technological supplies—. Previously, the same structural definition of the system had been used to study the issue of introducing commercial crops in the Bajío, Mexico, where the nutritional status of huge less-privileged sectors had strongly impaired, and the Mexican food industry was highly dependent on the international markets (García, 1984). However, a point of note is that each complex system shall have subsystems of its own based on the definition the research team had agreed. The subsystems within a complex system, as well as the system, are neither defined in advance nor once and for all.

In the TSC, a "subsystem" is identified with a "discipline" only in a very general respect and in the context of an interdisciplinary reasoning. We understand disciplines as the social, institutional, and legal organization that the scientific practice has developed throughout its history (García, 1994), whose arbitrary, diffuse and permeable boundaries are loosely associated with ways of asking questions about reality. Complex system research aims at contesting the very same questions defining the scope of the issue. That is why structuring the issue in a systemic way has as a starting point of interrelating processes and elements, and, it is from that point that other disciplines' viewpoints are sought after.

Two integrated systemic principles are involved in the before mentioned definitions: the principle of systemic articulation and of stratification (García, 2013). The first one refers to the fact that in a complex system the elements are related in varying degrees, thus creating different subsystems whose relationships set up the system structure. The second principle refers to the fact that each system requires a semi-independent analysis of its own dynamics, even though they are neither determined nor inferable from other levels. A third principle establishes the coherence between both: the systemic organization principle implies that a change in one of the subsystems impacts the totality and vice versa. This third principle makes us introduce two other elements from the TSC lexicon: functioning and function. García uses the first concept to name the set of activities of the organized totality. The second one is used to name the individual activities each subsystem performs in connection with the totality.

The relationships among elements within the system boundaries are not the only factors striking the issue: complex systems are "open systems", that is to say, they bear relation to external factors whose dynamics are autonomous from the system. The system's relational definition reaches its boundary conditions, which are detailed in the form of entry or exit flows. The most easily identifiable system flows are those implying an entry or exit of objects and material supplies through the system's physical boundaries, such as technological supplies or payments, as well as the products and remittances or profits the system makes and exports; another type of flows may be more difficult to identify, such as the decisions conditioning the way the system receives the benefits (García, 1984, p. 38). For example, regarding the agro-productive system in the Bajío, Mexico, area, the system interacts with boundary conditions defined by credit flows, introduction of technology, demand of certain products, imported food, and workers immigration; hand in hand with this, the system "exports" agricultural and processed products, workers, natural resources, profits, and remittances (García, 1984, pp. 57–58).

These flows determine the way elements are related. In this regard, note that subsystems also have flows, exchanges, and boundary conditions. As García (2000, p. 76) elaborates: boundary conditions do not "determine" processes occurring in a system (or subsystem) but, because they affect the internal system balance, they play a key role in the way the system changes and evolves. That is why the full system definition must include the most significant boundary conditions that can be identified.

Defining the related constituent elements, the differentiated subsystems within the system and boundary conditions provide with static view of the issue is Garcia`s synchronic description of system status.

#2.2. Processes, scales and levels of systemic analysis

The focus of the TSC analysis are not these static descriptions but the system's change and transformation processes, as well as the mechanisms governing these transformations (García, 2006, p. 61). It is evident that these changes and transformations also imply continuities that allow us to refer to changes —overt time— within the system itself. Recording these different statuses over time allows system process behavior, which is the first tool to be used in a diachronic analysis (García, 2006, p. 80).

From a constructivist point of view, we understand processes as a series of changes in causal relationships that are inferred among events. If we understand that these events refer to phenomena occurring over time, processes connect different system statuses. The TSC proposes 3 levels to analyze processes:

1. Analyzing local processes referring to changes within the subsystem boundaries and its interrelationships

2. Analyzing meta-processes referring to changes in the system structure, based on boundary conditions, and affecting the changes identified as local processes.

3. Analyzing macro-processes (or third-level processes) referring to changes in the system's boundary conditions (factors that are conjunctural or outside the system boundaries) affecting or favoring meta-processes.

Analyzing integrated processes from different levels is at the core of the systemic approach; however, there are also different timescales associated to these process levels, that is to say, different calendarizations linked to the frequency of the identified events. Integrating different timescales — which is needed to integrate process levels— makes us confront with the problem of considering how fast the interchange flows between a system and its environment change (García 2006:49). In this respect, the disruption and change in the system structure — rather than resulting from changes in the environment— are the consequence of its particular level of (un)stability and (in)vulnerability —structural properties— at a given moment and at a specific timescale (García, 2006, p. 149).

According to the TSC, these changes may be sorted out into:

1. Small-scale changes, which are within the system's capability of absorbing fluctuations within a certain timeframe keeping the system structure unchanged;

2. Major changes, which are beyond the system's capability of compensation over a certain period of time, thus encouraging a transformation in the relationships defining the system structure and a new way of organizing or structuring its elements.

For example, Castañares Maddox (2009) puts forward a complex system analysis to deal with the environmental issues in the Mesoamerican Biological Corridor area in Mexico. The analysis defines an environmental system with three subsystems: the ecological subsystem, the productive and economic subsystem, and the socio-cultural subsystem. According to the author, the chances to successfully carry out an intervention project on this system requires an environmental policy able to integrate different decision-making levels associated with the information exchange from the 3 system process levels. Hence, the "strategic" decisions proposed by the overall objectives are associated with macro-processes; the "tactical" decisions, in charge of regional technical units, should translate strategies into operational actions guiding the different actors involved in the issue, thus referring to meta-processes; and finally, the "operational" decisions, in charge of the scientific community and society, are linked to the local processes. As the author states, the chance to intervene in a complex issue can be summarized by paraphrasing the statement "Think global, act local" for "Think systemic, act integrated" (Castañares Maddox, 2009, p. 62). Making explicit the time element, we may say that the operational decisions prevail in the short term; the tactical ones, in the medium term; and the strategic ones, in the long run.

As a second example, let us get back to the before mentioned research study on technological policies in the pampean agriculture (N. Becerra et al., 1997). As the authors state in the conclusions, the strongest study hypothesis was that, taking the agro-pampean system as an integrated and open complex system whose boundary conditions make an impact throughout its structural development, a calendarization based on second and third level processes (specifically, changes made to the system through domestic policies and the markets' state of affairs, and associated, at the same time, with changes in international policies and markets) would concomitantly match up a first level process periodization (changes in the system's socioeconomic and physical relationships).

#2.3. Evolution of complex systems

The system's evolution approach, by the TSC, follows the developments of structural changes in open systems and dissipative structures (García, 2006, p. 145): evolution is not thought of as a linear or continuous process but as a succession of periods where the system keeps a stationary relative stability through disruptions and reorganizations (or self-organizations). A "stationary structure" is not a static structure. As stated before, the elements within complex systems' structures are under constant change, especially because of the exchange with their environment. Within certain boundaries, the system fluctuates in a "dynamic balance" that determines a period of relative stability for its structure. Note that this dynamic balance differs from the closed systems' balance in classic thermodynamics: it is precisely due to the exchange with the environment that an open system is able to remain unchanged in imbalance conditions (Piaget & García, 1988, p. 121). In this regard, some authors working on environmental issues refer to complex systems as "socio-environmental structures that behave like dissipative structures" (Espejel et al., 2011). The TSC proposal, which focuses on alternating stationary structures with reorganization processes under new conditions, takes its inspiration from Prigogine's work on structural evolutions with increasing levels of complexity.

From time to time, changes in boundary conditions create an imbalance that goes beyond the instability threshold the system can handle at its current state. It is then when a system reorganization occurs by which a new structure is organized (a different way for the elements to relate with each other), which is also stationary as long as boundary conditions remain the same. At other times, a structural change may be caused by a change in inner elements, such as an imbalance of interchanges among subsystems or if a subsystem has ceased to function, which forces a change in the other systems' functioning to guarantee the function in terms of the total system. But still, it is important to note that the latter, in García's words, is infrequent; the structural changes caused by changes in environmental flows being the most significant. In any case, the balance results from exogenous drives and endogenous configurations. This can be illustrated with the research studies conducted by an interdisciplinary team coordinated by García on the droughts that took place in the 70's and which preceded the food crisis (with high mortality and malnutrition rates) in Africa, India and Latin America areas. Under the title of "Nature Pleads Not Guilty", the studies concluded that the food crisis were mostly the result of worsened political and economic processes that would make the affected societies more vulnerable to the effects of droughts, which, from a physical and climatological point of view, had not increased at all (García & Spitz, 1986; García, 1981).

#3. Complex Systems Theory and Sociocybernetics

In our opinion, García's proposal is in line with the sociocybernetic outlook, as evidenced by his name presence in several recent works submitted to the International Sociological Association's RC51 events as well as to the association's Journal of Sociocybernetics. In this section, we include some notes on the main programmatic convergences and divergences.

According to Hornung (2005), sociocybernetics may be defined as the application of systems science, which includes both first and second order cybernetics as well as its methodologies, empirical research practices, and ethical and epistemological analysis, in the domains of problems in sociology and other social sciences. In this spirit, sociocybernetics is also one of the different programs that have aimed at bridging the gap between the social sciences and the developments in the complexity sciences (Castellani & Hafferty, 2009; Dijkum & Schroots, 2006; Lee, 2002).

As stated before, García understands that complex systems research requires a multidisciplinary team working with a methodology intended to integrate disciplines, such methodology having as a core component a joint modeling of the issue. García's proposal thus has two essential guidelines in common with sociocybernetics: the interdisciplinary spirit that has been with sociocybernetics from its inception and using modeling as a core technique (Scott, 2004). It is even more important to highlight that these methodological proposals are based on a constructivist epistemology with a strong accent on reflection (Scott, 2001). We will get back on this shortly.

García's theoretical proposal —per se— is in accordance with the key principles of sociocybernetics, as detailed by Hornung (2005): a relational world view through which its structures are identified; a processual perspective on interchanges with a special focus on self-organization. However, it should be noted that the TSC does not include a second-order reflexivity vocabulary enabling to analyze auto-reference processes. Within TSC, explicit second order reflexivity is limited to the epistemological considerations of the interdisciplinary dynamics. Observed systems rather than observing systems are the TSC's object of study. Perhaps, the pursuit of including physical phenomena, along with biological and social behaviors, could play a restrictive role here. This restrictiveness, nevertheless, does not prevent the TSC from dealing with circular causality behaviors, positive and negative feedback, although it does it from the approach of changes in dissipative structures.

Characterizing the TSC's relevance to sociocybernetics wouldn't be complete unless we mention its compatibility with one of its most significant programs: the Social Systems Theory proposed by Niklas Luhmann (1984). As it is well known, Luhmann's objective is to hit upon a plausible theory based on communication systems to describe society and its complexity (G. Becerra, 2013). Clearly, this is not the TSC's objective, whose relevance to sociology is not other than providing a general framework to deal with "complex issues" in an interdisciplinary way. Yet both approaches are not entirely incompatible, as shown by the large number of issues associated —although not always entirely explicitly— to the different "social systems" that have been dealt with (Geyer & van der Zouwen, 1991; Menanteau-Horta & Menanteau, 2003; Parra-luna, 2000). As the TSC remains on a more general and abstract level it enables to conceptualize all sorts of social scenarios as long as it provides for analyzing the impact of human practices in the biological and physical world.

It could be argued that Luhmann's "autopoietic turn" introduces a problem for this attempt, but this may be the case for any theoretical dialog with Luhmann's theory interested in a systemic intervention. To the best of our knowledge, the most important challenges that a sociology based on Luhmann's work currently faces can be stated as follows: How are second order descriptions going to be linked with first order descriptions for an intervention scenario? How to illustrate the world's materiality within Luhmann's sociological descriptions? (Farías, 2014; Mascareño, 2011).

With an orientation toward dealing with "issues" and "problems", the TSC may serve as a general framework to insert a performance analysis of those social systems considered to be relevant. The

TSC's theoretical guidelines aim at analyzing the relationships between social aspects and the rest of the complex system along with its physical and natural elements. It is not about subordinating a question to another one but getting dialectical integrations under the look of co-evolutions. Still, we know —in the spirit of García (1990)— it is not in the theory nor in the concepts where this integration is hard to achieve. The challenges in complex systems research are mainly associated to the human element engaged in the practice: pondering own views along with the assumptions ruling own conceptualizations, designing approaches and drawing conclusions collaboratively, among others. All of these methodological and epistemological problems are relevant to the sociocybernetics committed to dealing with social issues with a political outlook (Geyer, 1995; Hornung, 2006; Scott & Shurville, 2005).

In our opinion, García's proposal may make several contributions to these challenges: a dialectical analysis of the interdisciplinary praxis based on differentiations and integrations and supported by a strong reflexivity on research questions, observables and system variables; a discussion of how central the researchers' political viewpoint is to framing the questions-guidelines and constructing the system; making observables and inferences explicit along with outlining the empirical complex. It is important to note these problems are introduced in the context of a discussion between constructivism and logical positivism (García, 2000, 2001) in such a way that invites to critique methodologies and dominant assumptions in social sciences. Along these lines, we also think it is important to establish a dialog between this version of Piaget-inspired constructivism with the "radical", "biological" and "operational" traditions (G. Becerra, 2014; Glasersfeld, 1995; Luhmann, 1990; Maturana & Varela, 1980), especially regarding the sociogenesis of scientific knowledge, and with von Foerster's constructivist ethics (2003).

Conclusions

This work is a summarized presentation of Rolando García's approach, both of his proposed methodology and epistemological assumptions as well as his conceptual definitions and theoretical principles. Focusing mainly on the approach's theoretical aspect —since, in our opinion, it is the less explored road—, we aimed at showing its relevance, potentialities, and difficulties to sociocybernetics.

Lastly, we would like to highlight one last singularity of Garcías's approach. We refer to how to understand the "complexity" notion. It is mostly understood as the complex phenomena whose relationships can be modeled through non-linear equations. This is an approach seeking to import some mathematical and technical accomplishments from other sciences to social sciences. Another meaning of "complexity" is the one associated to "complex thought", which is closer to the epistemological problem of bringing different points of view together to articulate new questions. Being aware that both meanings coexist, it is our opinion that the first one has prevailed in sociocybernetics whereas the second one has made a greater impact on García's approach, and, which is more important, has allowed founding a theoretical and methodological approach deserving to be explored.

Notes

The authors would like to express their gratitude to an anonymous reviewer for her thought-provoking comments.

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