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Power and limits of dynamical systems theory in conflict analysis

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POWER AND LIMITS OF DYNAMICAL SYSTEMS THEORY IN CONFLICT ANALYSIS

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Abstract:

One of the most exciting new approaches in conflict research applies Dynamical Systems Theory (DST) to explain the devastating dynamics of intractable conflicts. This paper describes what makes this approach so powerful, and discusses some of its limitations that become visible in the mathematical models of DST that are available so far. In its final section, some possible directions for further research are sketched with a special focus on identifying the elements of a conflict whose dynamics could be reconstructed by means of Dynamical Systems Theory.

POWER AND LIMITS OF DYNAMICAL SYSTEMS THEORY IN CONFLICT ANALYSIS

Introduction

One of the most exciting new approaches in conflict research applies Dynamical Systems Theory (DST) to explain the devastating dynamics of intractable conflicts (cf. Coleman, 2006; Coleman et al., 2006; Coleman et al., forthcoming; Nowak et al., 2006). This paper describes what makes this approach so powerful, and discusses some of its limitations. In DST, a "dynamical system" is defined as "any system whose behavior at one point in time depends in some way on its state at an earlier point in time" (Elman et al., 1998 <1996>, p. 210). DST is, first of all, a mathematical approach that focuses on the formulation of equations whose repeated iteration in computer simulations allows a reflection on certain patterns that are observable in dynamical systems (cf. Strogatz, 2000 <1994>). Since there are—as far as I know—as yet no mathematical models available that demonstrate how DST could be applied in conflict analysis, I will discuss an example developed by Nowak et al. (2002) that shows how the approach can be used to describe the "emergence of personality" through "interpersonal synchronization." The analysis of this example will illuminate some limitations of the approach that should be relevant also for possible models of conflict dynamics.

Based on these limitations, I will sketch in the final section some possible directions for future research. As I will show, it will be important to identify, first of all, the elements that are relevant for conflict dynamics. Instead of using individuals, groups, facts, or events as basic units of analysis, I propose to focus exclusively on observable signs and representations that are used in interactions (i.e., claims, arguments, stories, theories, models, diagrams, maps, concepts, symbols, images, gestures, and actions). The basic idea is that, on the one hand, facts and events are always framed by stakeholders and, on the other, individual and collective identities can only be derived from the signs used in interactions. It is impossible, for instance, to reconstruct an individual's belief-value system "objectively" because it is (a) dynamic, (b) partly not structured, (c) depends on the respective environment which varies from situation to situation, and (d) any attempt to do so is itself determined by the observer's belief-value system (Hoffmann, 2007). Signs and representations, by contrast, can easily be documented. What is controversial are only their interpretations; but those interpretations again are visible in further signs and representations.

Methods

This is a theoretical paper that is based on a philosophical approach to cognitive science on the one hand, and to semiotics, the theory of signs and representations, on the other. Since I am focusing here on an assessment of Dynamical Systems Theory as a tool in conflict analysis, the methods used are critical analysis, conceptual analysis, and epistemological reflection, that is a reflection on the question how knowledge claims can be justified. I should emphasize in advance that, from my point of view, the main function of philosophy in conflict research is twofold: working on the clarification of language, and critical analysis of theoretical approaches. We all know that there is no scientific communication and research without scientific terminology, models, and theories. Especially in highly interdisciplinary research fields, however, mutual understanding is often hampered by the fact that a language, or a theory, that might be well-established in one field gets easily misunderstood, or misapplied, in another. Clarifying those problems can help to develop new perspectives for future research.

Dynamical systems and conflicts

A very simple example of a dynamical system as defined above is the centrifugal governor developed by James Watt in 1788 to regulate his steam engine (Figure 1). To keep the engine from "running away," the amount of steam released is dynamically controlled by what has been called in cybernetics "negative feedback" (Wiener, 1948). As the rotation increases, the flyballs move outwards, and this motion is translated by a series of rods and arms to a throttle valve, reducing its aperture, so that the engine—and with it the rotating balls—slow down, opening the valve again, and so on. The governor can be positioned in a way that the engine's speed moves around a certain value. In Dynamical Systems Theory, this value would be called the system's "attractor," because whatever happens, the system's behavior is "attracted" by this value, it converges on a static and predictable behavior.

The advantage of this fascinating engineering solution is obvious: There is no need for external control, and no need for the formulation of physical laws or an exact description of what happens as needed for external control. The system regulates itself by means of only one feedback loop: the engine's output gets "feed back"—modified by the respective opening of the valve—into itself.

The simplicity of dynamical systems like the steam governor opens up exciting perspectives for social sciences. What if we could replace in organizations hierarchical control by the "art of managing and changing contexts" since order emerges "naturally" in dynamical systems (Morgan, 1997, p. 266)?—that is, shaping "the parameters that can define an appropriate context, while allowing the details to unfold within this frame" (267). What if we could use the attractor idea to understand why intractable conflicts "take on a unique, self-sustaining character, where strong patterns of internal dynamics make them more and more resistant to outside intervention" (Coleman et al., 2006, p. 61)?—strong and stable conflict attractors as we can find them in "patterns of thinking, feeling, and acting" (Coleman, 2006, p. 330).

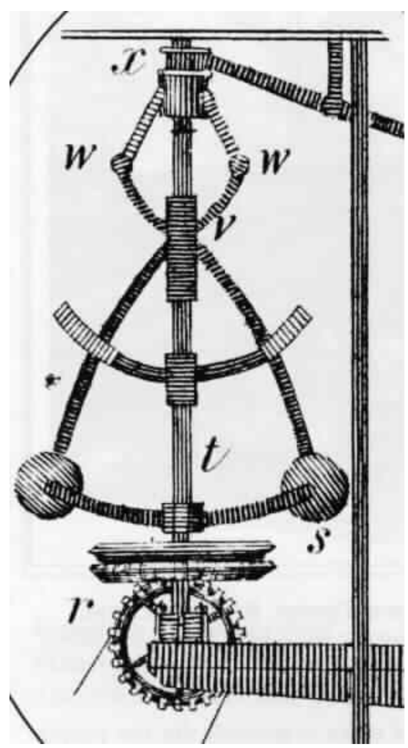

Figure 1: Watt's original flyball governor, from the 1832 Edinburgh Encyclopaedia (http://www.uh.edu/engines/epi977.htm)

The excitement about Dynamical Systems Theory (DST) gets an additional push based on what we know about more complex systems. Considering cases which are determined by two different attractors, we can use DST to describe "the management of change" as an effort "to push systems into far from equilibrium states by generating instabilities and crises that will 'flip' a system from one trajectory to another" (Morgan, 1997, p. 272). And in conflict research, DST "provides frame-breaking insights into the nature of such patterns [of thinking, feeling, and acting], and thus can offer new tools to move [conflicts] beyond intractability" (Coleman et al., 2006, p. 61). Although it will hardly be a trivial matter in practice, the language developed in DST allows us to reformulate the goal of conflict management and conflict resolution by saying that the dynamics of conflict systems can be changed through attempts to "introduce negative feedback loops that deescalate the conflict once it reaches a certain threshold, create the conditions for alternative peaceful attractors to emerge, and work actively to disassemble strong negative attractors" (Coleman, 2006, p. 330).

An example that can serve to demonstrate at the same time the possibility *and* the difficulty of those reframing processes is the so-called hysteresis effect in human perception (cf. Haken & Haken-Krell, 1997). It describes by means of a simple two-attractor system how what we "perceive" is determined by the *history* of our perception; what we perceived earlier determines what we perceive now. Although the "objects" of our perception are exactly the same when we look at Figure 2, it makes a difference whether we start the process of looking at these drawings on the left side of the first row, or on the right side of the second one.

In Dynamical Systems Theory, the function of a fixed point attractor—that is an attractor in systems where any input leads eventually to a single output value, as in the

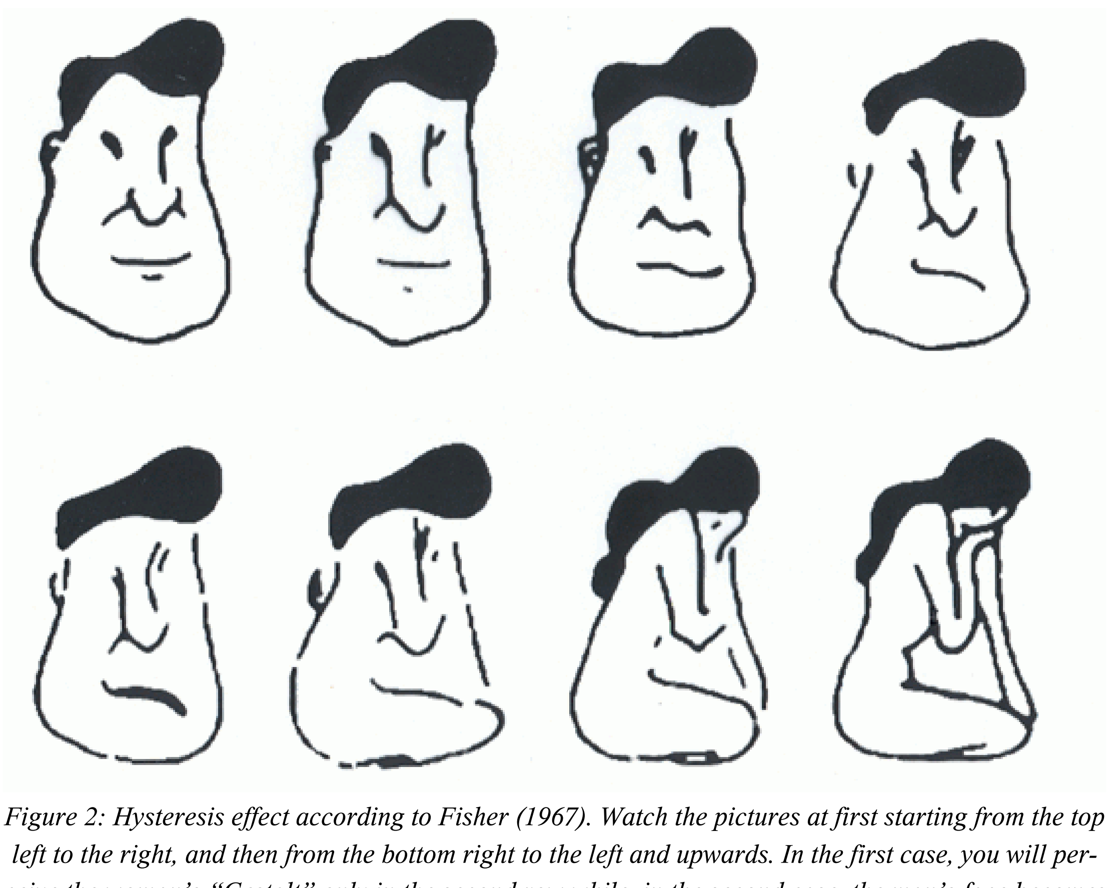

Figure 2: Hysteresis effect according to Fisher (1967). Watch the pictures at first starting from the top left to the right, and then from the bottom right to the left and upwards. In the first case, you will perceive the woman's "Gestalt" only in the second row while, in the second case, the man's face becomes visible only in the first row. What you perceive is determined by two different attractors. The effect of these attractors, however, is also determined by the history of your perception process. (from http://www.scholarpedia.org/wiki/images/b/b1/Self-Organization_in_brain_Fig6.gif).

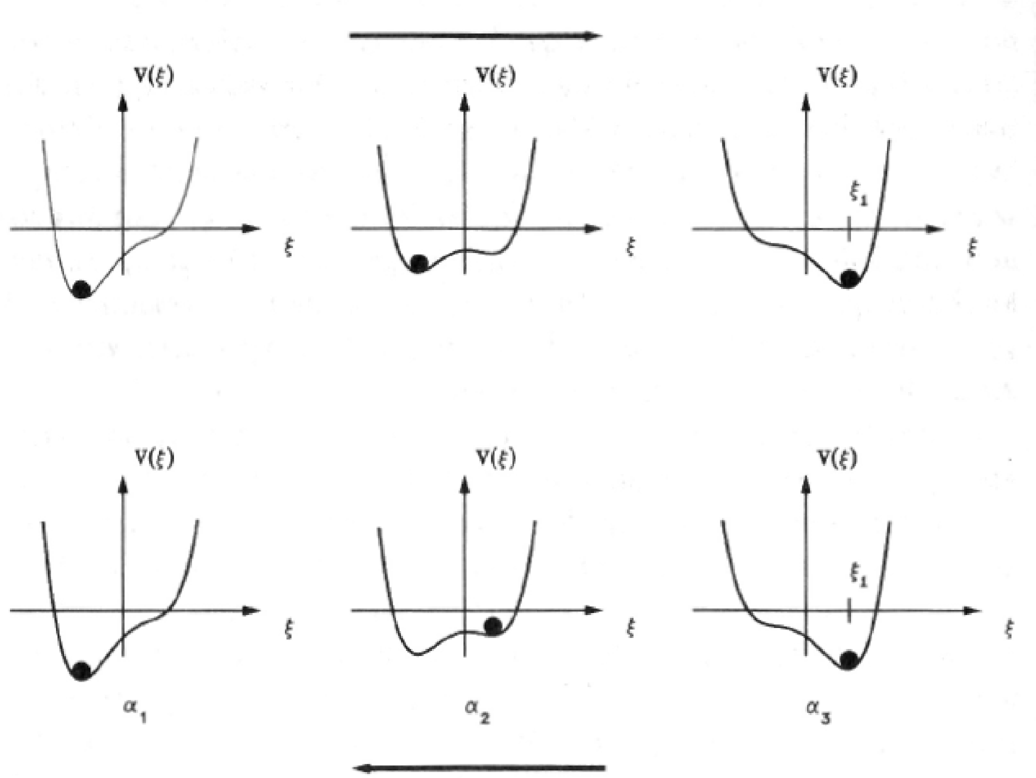

Figure 3: The hysteresis effect represented as a changing landscape with two attractors. The first row describes the process of perceiving the drawings in Figure 2 starting with the man's face, the second starting with the picture of the woman. (from Haken & Haken 1997, p. 90)

case of the centrifugal governor—is usually visualized by the picture of a ball moving in a landscape of hills and valleys which is determined by the control parameters of the system. The hysteresis effect of Figure 2 could be represented in DST by Figure 3. Here we see in each row in the graph on the left (a_1) what happens when we perceive the man's face—symbolized by the ball at its attractor point in the left valley—and in the graph on the right (a_3) the perception of the woman. In both these cases the visual stimulus (i.e., the ball) gets interpreted by a neural structure (i.e, the landscape) that allows a clear identification of what we see. The first row describes the history of our perception when we start with the man's face, and the second row when we start with the picture of the woman (note the two arrows signifying both these directions). The crucial difference between both processes becomes visible when we compare both the middle graphs (a_2). The change of the drawings is not linearly related to a change of the activated neural landscape. By contrast, the neural change is delayed. Based on the respective history of both perception processes, the attractor will be in different valleys.

Coleman et al. (forthcoming) use the hysteresis effect as defined in Dynamical System Theory to describe an interesting phenomenon in the development of conflicts. It seems to be often the case that, on the one hand, the intensity of a conflict increases "catastrophically" (in the sense of Thom, 1975) after the sum of forces promoting the conflict passes a certain threshold while, on the other hand, the sum of forces at which the same conflict decreases again sharply is much lower than in the first case. It is again the history—whether the conflict builds up from a more or less peaceful situation, or decreases from a highly controversial state—that determines at which point a shift of perspective, or changing the attractor, is possible. Coleman et al. (forthcoming) interpret this phenomenon as follows:

> Once the parties to conflict have developed a stable way of thinking about and behaving toward one another ..., the problem no longer revolves around issues *per se* but rather centers on the mental and behavioral patterns defining the relationships and institutions which constitute the context of the conflict. (p. 7)

The relevance of those "patterns" has been discussed intensively under the heading of "framing," or "sensemaking" (Gray, 2006; Hoffmann, 2007; Lewicki et al., 2003; Putnam & Holmer, 1992; Tannen & Wallat, 1993; Weick, 1995). Dynamical Systems Theory, however, provides a language by which a new light can be shed on processes that we often observe in conflict management:

> A person or group may encounter a wide range of ideas and learn of alternative action scenarios, for example, but over time only those ideas and actions that are consistent with destructive conflict are embraced as relevant and credible. Attractors, in short, channel mental and behavioral experience into a narrow range of coherent (either positive or negative) states. Attempting to move the system out of its attractor promotes forces that reinstate the system at its attractor. This means that attempts to change a state of destructive relations that neglect the mechanisms that continually reinstate the conflict are likely to be futile, resulting only in short-term changes. To promote lasting change, it is necessary to change the attractor states of the system. This is no easy feat, since it is tantamount to changing the mechanisms responsible for the system's dynamics. (Coleman et al., forthcoming, p. 8)

Based on this, Coleman et al. (forthcoming) suggest that the aim of conflict resolution should not be to push a person or group "out of its equilibrium, but rather changing the social system in such a way that the equilibrium among forces is changed" (ibid.). Only in this way a "permanent change in the structure" could be achieved.

The gravity of the challenge posed by these formulations is easily seen when we consider intractable conflicts like in the Middle East. The hysteresis example in Figure 2 above demonstrates pretty convincingly that already the "normal" perception we all experience is determined by factors that are absolutely inevitable: the history of our perception process and the existence of attractors that allow us to abstract complex sensual stimuli to single bits of information (“face” versus “woman”). While in this example the activated neural structure of our visual system and its history determine in each situation what we see, I would propose to call it a belief-value-attitude system that determines in conflicts how people make sense out of what happens (cf. Hoffmann, 2007). Especially in long lasting, intractable conflicts those belief-value systems can be so stable and petrified that whatever happens gets interpreted in a way that the system itself remains unchanged. It is always possible simply to neglect what does not fit into a given system of convictions, or to distort its perception in such a way that it can be comprehended without changing the underlying system. In those situations, interventions of third parties are often interpreted according to exactly the same patterns so that even the best-intended efforts only enforce a further round of escalations. (Cf. the example of the reactions provoked by a committee that the president of Columbia University installed to analyze an Israeli–Palestinian conflict on campus; Coleman, 2006, p. 332).

In spite of pessimism of this sort, Coleman et al. (forthcoming) formulate a series of suggestions for what could be done to resolve even those kinds of conflicts. I will focus here only on their “first step”:

> The first step is to identify the relevant elements and the nature of their linkage. With this information, one is in a position to disrupt the most important linkages and thereby decouple the elements and issues. The complexity of all the elements and the mechanisms by which they influence each other is likely to vary a great deal from one instance to another and thus require a careful case study. (Coleman et al., forthcoming, p. 23 f.)

Indeed, it seems to be a precondition for applying Dynamical Systems Theory that the *elements* whose dynamics are the focus of this approach must be identified. That this could be a real problem is the theme of the next section.

Limitations of Dynamical Systems Theory

Dynamical Systems Theory is, first of all, a mathematical theory which has been applied primarily in physics, chemistry, engineering, and in developmental biology (Smith & Thelen, 1993; Strogatz, 2000 <1994>; Thelen & Smith, 1994; van Geert, 1994), but also in social psychology (Nowak & Vallacher, 1998) and organizational behavior (Axelrod & Cohen, 1999). Of interest with regard to cognitive and perceptual processes is the volume *Mind as motio: Explorations in the dynamics of cognition*, edited by Port & van Gelder (1995). As the editors write in their introduction under the heading “It’s About Time: An Overview of the Dynamical Approach to Cognition”: in cognitive science, the dynamical systems approach has been developed as a research program in contrast to the traditional “computational approach to cognition”:

> The cognitive system is not a computer, it is a dynamical system. It is not the brain, inner and encapsulated; rather, it is the whole system comprised of nervous system, body, and environment. The cognitive system is not a discrete sequential manipulator of static representational structures; rather, it is a structure of mutually and simultaneously influencing change. Its processes do not take place in the arbitrary, discrete time of computer steps; rather, they unfold in the real time of ongoing change in the environment, the body, and the nervous system. The cognitive system does not interact with other aspects of the world by passing messages or commands; rather, it continuously coevolves with them. (van Gelder & Port, 1995, p. 3)

With its inclusion of the environment *as part* of human cognitive systems, this approach is comparable—considering the complexity and seriousness of the problems involved—to conflict analysis where the delineation of a conflict is one of the hardest questions to decide: what belongs to it, and what does not? Are mediators part of the problem or part of the solution? However, based on many research results over the last decade it is indeed convincing to suggest that cognition cannot be reduced to what happens in our brains. Based on a broad discussion of “distributed,” “situated,” or “embodied cognition” (Hutchins, 1995; Clark, 1998), Clark & Chalmers (1998) coined the term “extended mind” which signifies the idea that an individual’s cognitive abilities can only be understood as parts of “cognitive systems” that include the respective environment and social settings as “driving forces” for cognitive processes (cf. Hoffmann, forthcoming; Nowak et al., 2002). The challenge, and the limitations, that this poses for the application of Dynamical Systems Theory is frankly acknowledged by van Gelder and Port:

> Natural cognitive systems are enormously subtle and complex entities in constant interaction with their environments. It is the central conjecture of the Dynamical Hypothesis that these systems constitute single, unified dynamical systems. This conjecture provides a general theoretical orientation for dynamicists in cognitive science, but it has not been (and in fact may never be) demonstrated in detail, for nobody has specified the relevant magnitudes, phase space, and rules of evolution

> for the entire system. Like scientists confronting the physical universe as a whole, dynamicists in cognitive science strive to isolate particular aspects of the complex, interactive totality that are relatively self-contained and can be described mathematically. Thus, in practice, the Dynamical Hypothesis reduces to a series of more specific assertions, to the effect that particular aspects of cognition are the behavior of distinct, more localized systems. (van Gelder & Port, 1995, p. 11)

What this focusing on the feasible in practice means becomes visible, for instance, in the undertaking of Nowak et al. (2002) to explain the "emergence of personality" and individuality as based on social interaction. Their convincing starting point is the thesis that individuality and social embeddedness

> are mutually reinforcing. The propensity for coordinating with others plays a key role in creating individuality, and the distinct personalities that are shaped in this fashion constrain the nature of social interactions and hone relationship preferences. (Nowak et al., 2002, p. 292).

Their attempt "to delineate the nature of this reciprocal linkage between social coordination and individual variation" (293) by means of Dynamical Systems Theory focuses on the formulation of equations to describe the change in the dynamical systems they studied. Since in this case the paradigm for understanding the "reciprocal linkage" mentioned above is the "synchronization" of two individuals' behavior over time, they propose two equations that describe for each of the two persons how their "behavior" at a certain point in time is not only dependent "on his or her preceding state but also on the preceding state of the other person" (302). As is characteristic for dynamical systems, these equations are iteratively applied so that the outcome of the first application becomes an input for the second, and so on. Since both equations are coupled—the resulting behavior of one person at a certain point in time is represented in the equation that produces the other person's behavior at the following point in time, and *vice versa*—the repeated iteration produces for each person a series of "behavior" values whose combination in a graph represents the development of synchronization over time.

The elements that are reflected in these equations are only three: the *behavior* of the individuals (x_1 and x_2), a *control parameter* for each of them (r_1 and r_2) that "corresponds to internal states (e.g., personality traits, moods, values, etc.) that shape the person's pattern of behavior (i.e., changes in x over time)," and a value (α) that "corresponds to the strength of coupling and reflects the mutual interdependency of the relationship" between the two persons (300-303). The individuals' behavior is the dynamical variable whose change in time is observed in computer simulations in dependence on the other two values. While different values for the strength of coupling are set by the authors, they seem to assume that the two individuals change the control parameters—that is, the values r_1 and r_2 representing their own, and an assumption of the respective others', internal states—by themselves. However, it remains unclear how this change is realized in the simulations (304 f.; this is also a problem of their simulations of dynamics of equilibria, pp. 312-318). The provided equations themselves represent r_1 and r_2 as "parameters," not as variables; that would imply that they are also externally set. (In Nowak & Vallacher, 1998, where the same material has been published first, the authors are more explicit: "*We* systematically varied the value of *r*," p. 195; my emphasis).

The outcome of various simulations show a series of interesting patterns that Nowak et al. (2002) use to illuminate several important aspects regarding "the mechanisms responsible for" the "reciprocal relationship between personality and social interactions" (298). At this point, however, I would like to focus on the *limitations* of this approach. For that, it is important to reflect on what the repeated iteration of the two equations actually reveals, and what it does not reveal.

My first point refers to the simplicity of the mathematical model used in this case. Nowak et al. (2002) claim that "the fundamental dynamic properties of even quite complex systems" can be captured by relatively simple models of nonlinear dynamical systems as formulated in their two equations:

> The abundance of interactions among variables underlying psychological phenomena ... clearly indicates that humans are nonlinear systems. Yet the enormous complexity of human thought and behavior would seem to render the modeling of human systems in their entirety an impossible task. As it happens, however, the qualitative behavior of a nonlinear system does not depend on the nature of the elements that compose the system or on precise specification of all the factors that influence the system. Rather, the system's qualitative behavior usually depends on the nature of the interactions among a small set of variables that are critical for describing the system's behavior. In this sense, the nonlinear dynamical systems approach typically concentrates on building models that describe the most important relations among elements. (300)

However, it is absolutely clear that these mathematical models never show more than what becomes visible in the values of the elements that are represented in the equations. That means, the more abstract the elements that go into the equations are, the more abstract are the patterns of behavior that can be observed. Therefore, the simplicity of the models used in this example comes at a high price: the "behavior of *x*" is as unspecified a category as the "control parameter *r*" that encompasses everything without distinction that constitutes an individual: beliefs, values, moods, temperament, personality, and so on. The "careful case study" that is required according to Coleman et al. (forthcoming) as the first step of conflict analysis in order "to identify the relevant elements and the nature of their linkage" (23) is only of limited value when at the end all specifics disappear in something like "*r*."

This consideration is not meant as a critique of the article by Nowak et al. (2002). As a criticism it would completely miss the point since the authors do not aim to capture the multiple differences that appear in individuals and their interactions. (Cf. also Nowak & Vallacher, 1998, p. 194: "The simplifications are obvious.") What they intended is explicitly a "formal model," a "formal framework for describing how individual differences both arise from and shape social interactions" (Nowak et al., 2002, p. 323):

> It is important to note that the logistic equation is generic in form, is intended to reflect basic processes involving the conjunction of conflicting forces, and does not depend on specific identities of *x* and *r*. Thus, *x* can refer to behavior at various levels of identification, from simple movements to broad action categories, each of which may be associated with a correspondingly different time scale (e.g., seconds vs. days). The identity of *r* is similarly flexible and can refer to a wide variety of internal states, from momentary concerns and moods to basic dimensions of temperament and personality. (Nowak et al., 2002, p. 301 f.)

However, this generality of the basic values *x* and *r* means that this model does not help when we need to consider the *diversity* of behavior, *tensions* among an individual's beliefs and values, *multiple ways* to perceive the other, or *misunderstandings* between individuals. What the model can show are general patterns of development whose determining factors are reduced to what is manageable by the equations.

My second point is that the claim that a complex system's behavior could be described by only "a small set of variables that are critical for describing the system's behavior" (300) must be justified. How can we know that just those variables that are represented in a certain equation are the right ones to describe the behavior of a complex system adequately? And: all this is about identifying the right equations, but how can we know that our equations are sufficient? The only way to justify both sets of assumptions is simply to try it. It's an experimental approach. The equations can only be justified by showing that the patterns we create based on our mathematical models are analogous to what happens "in real life." However, this implies an epistemological circle: In order to justify the mathematical model, we must already know what the outcome of our simulations should look like. But the whole purpose of the mathematical model was to describe something we don't know. The goal was to clarify the "mechanisms responsible for" the "reciprocal relationship between personality and social interactions" in a situation where we only have "intuitive" ideas (298). But how can we justify our intuitive ideas by a mathematical model that itself can only be justified by those ideas?

A third point concerns the fascination we experience when observing the outcome of computer simulations that show what happens when we repeat a certain calculation iteratively hundreds of times. It is important to note that this fascination results from the power of mathematical models to *mirror* what seems to happen in the real world. But what we observe are equations, not reality. Even if we formulate equations that seem to fit perfectly with what we believe we know, these equations do not *explain* what happens; they are models, not the reality.

Both this gap between model and reality and the epistemological circularity mentioned above lead to my last point: What is proved by those mathematical models is the *logical possibility* of certain developments. It is indeed fascinating to know that the application of pretty simple equations can lead to highly complex dynamics, and all this "without the control of a higher order agent" (Nowak et al., 2002, p. 298 f.). But all this happens in a maximally controlled environment. Nothing in the world is better controlled than a mathematical equation. Whatever the outcome may be, it is absolutely determined by the variables that go into the equation, and the specific form of this equation. Reality, as we all know, looks different.

Discussion and directions for future research

The example for which I tried to reveal some limitations of Dynamical Systems Theory as a tool for conflict analysis is about interpersonal synchronization, not about conflicts. I chose it because I do not know of any mathematically elaborated application of DST to conflicts. In another paper on which two of the authors of Nowak et al. (2002) collaborated with others, the authors admit that DST is still an "emerging framework" whose formulation so far is "preliminary" (Coleman et al., forthcoming, p. 30; cf. Nowak et al., 2006). However, based on what I discussed in the last section, the difficulties for formulating a mathematical model that can describe the dynamics of *conflicts* should be much harder than in the example discussed above. Developing and changing one's own internal states through synchronization at least seems to be a case where it might be legitimate to reduce a full panoply of different mental states—"traits, values, goals, anticipated consequences (negative as well as positive)" (Nowak et al., 2002, p. 325)—to a single variable in an equation. For conflicts, however, this would obviously be too simplistic. Given the fact that we are always looking for a "common ground" for parties to a conflict, we are presupposing that there are *differences* in internal states. Not everything is adversarial. For the resolution of conflicts it seems to be crucial to differentiate stakeholders' internal states at least so far that intervention strategies can be applied.

It remains to be seen whether it will be possible to develop mathematical models to simulate conflict dynamics in more sophisticated ways. What Dynamical Systems Theory provides so far for conflict research is, first, a variety of useful metaphors—like the landscape metaphor used in Figure 3 above, or "attractor" and "negative feedback"—and, second, a general model for the dynamical interdependence between particular acts of interpreting events, facts, and other people on the one hand, and a more general "landscape" of attractors on the other that can describe how "framing" really works, and how "reframing" is possible by changing a landscape. (Wittgenstein, 1972 <1949-51>, by the way, used a very similar metaphor for the same problem: he talked about the mutual shaping of a river and its bed). This general model provides important insights that are relevant also for the practice of conflict management; for example the following ones (for more, and for the details, see Coleman, 2006; Coleman et al., 2006; Coleman et al., forthcoming; Nowak et al., 2006):

- In the long term, it is more important to change "the ensemble of possible and achievable states of the system" than to change only "the current state of the system;" or to say it metaphorically: it is better to change an attractor landscape than to move a ball in always the same valley. "Changing the state of the system, whether in a positive or a negative direction, is easily observable and, depending on the direction, often dramatic or spectacular. Changing the attractors of the system, in contrast, is more likely to be a gradual and far less visible process" (Nowak et al., 2006, p. 15).

- Since escalation of a conflict can be described as a "reduction of multidimensionality" (Coleman, 2006, p. 329), the challenge is: "Restore multidimensionality and balance the system" (343). This refers to the consideration that in "any

> healthy relationship—whether between individuals, groups, or nations—there are likely to be many distinct issues and dimensions along which the relationship is experienced (e.g., my friend is chronically late and tends to exaggerate the truth, but is generally well-intentioned, funny, and kind). Such multidimensionality and complexity in relationships mitigates against malignant social relations. For instance, if my friend harms me, our common goals and bonds should buffer my experience of the harm and constrain any overly aggressive response. Under these conditions, I am able to maintain a nuanced understanding of my friend, the act, and even myself (my role and responsibility in bringing about the act)" (329).

However, as Nowak et al. (2006) correctly state,

> the general model we have outlined needs to be enriched by content-specific understanding of real-world conflicts, clear specification of psychological and social mechanisms operating in the respective domains of conflict, and insight into the ways in which these mechanisms become inter-linked, resulting in a collapse of complexity and the resultant self-organization of conflict. (16)

For future research, the crucial question will be what exactly we can achieve by Dynamical Systems Theory. Depending on the answers to this question, different research programs can be formulated, and the next steps can be specified. Basically, I can see three different possibilities of applying DST in conflict analysis and management. Objectives could be to

1. describe general patterns of possible conflict dynamics over time. This would be purely descriptive. For this, mathematical models could be used whose development, however, would presuppose to distinguish a list of parameters that is rich enough to capture the essential elements of conflicts. Knowing those parameters would be extremely helpful to developing, for example, theories of reframing and "cognitive landscaping."

2. "map the ecology" of a conflict with all its events and feedback loops as suggested by Peter Coleman. "This method not only captures the multiple sources and complex temporal dynamics of such systems, but it can help identify central nodes and patterns that are unrecognizable by other means" (Coleman, 2006, p. 338 f.). In this case, Dynamical Systems Theory would be applied by the professional analyst. Its application, however, does not necessarily include mathematical models. It would be sufficient to use only the metaphorical aspects of DST to develop a certain mapping notation that can describe the dy-

namics of conflicts in a qualitative way.

3. use visualizations of how the dynamics of a concrete conflict developed in the past—and might develop in the future—as a tool to stimulate reflection of negotiators in concrete conflict management. This would be similar to Coleman's suggestion mentioned above, but it would presuppose to develop a mapping method that can be used by stakeholders themselves. It should be possible to represent also their own interpretations of what happens—and their framing processes—in those maps. This proposal builds on a cognitive-semiotic framework that stresses the learning possibilities provided by "diagrammatic reasoning" (Hoffmann, 2005, submitted).

While the use of Dynamical Systems Theory can be limited in (2.) and (3.) to its metaphorical and qualitative aspects, it might be possible to utilize also its mathematical possibilities if the problem of identifying the crucial elements of a conflict (that are to be represented as variables in DST equations) can be solved. With regard to this central problem, I can offer only some speculations here that are based on the following assumptions:

a) Since whatever happens in a conflict might be framed and interpreted by the conflicting parties in different ways, it does not make much sense to use facts and events as the basic elements that should be represented in maps and equations. Instead, I propose to represent only the *signs* by which those facts, events, and their interpretations are presented in interactions. It does not matter what happened; what matters is what people *say* happened. Even if their interpretations are completely biased and misleading, that's the point where we have to start.

b) Focusing on signs and representations makes my approach basically a *semiotic* approach. I am reducing what happens to signs and representations. Of course, any sign (i.e., claims, arguments, stories, theories, models, diagrams, maps, concepts, symbols, images, gestures, and actions) can be interpreted in different ways. But the point is: Any of those interpretations can again be represented in signs. Based on this, the chronological development of a conflict forms a *semiosis*, that is as an ongoing process of sign production and interpretation (Krampen, 1997; Liszka, 1996).

c) According to the approach of Nowak et al. (2002), it would be essential to identify the "control parameters" that determine how individual behavior and mental states dynamically change over time, that is the underlying beliefs, values, attitudes, moods, personality traits, and temperaments. From an epistemological point of view, however, it is clear that any assumption of those control parameters remains hypothetical. There is no way to determine those parameters "objectively." The best way to formulate hypotheses regarding those internal states is to look at the processes by which signs get interpreted by further signs. This process can be described as "sensemaking," a process I would define as interpreting data in such a way that they fit into a belief-value-attitude system. A belief-value-attitude system is a network of those elements that is consistent from its bearer's point of view. A belief is defined here as that cognitive state we are in whenever we take something to be the case or regard it as true. Values are defined as behavior guiding beliefs that are based on principles, needs, interests, or preferences (cf. Hoffmann, 2007). Since any interpretation of what happens in a conflict can be described as sensemaking in this sense, we can reconstruct underlying belief-value-attitude systems by observing those interpretations.

d) Belief-value systems can, at least partly, be represented as concept networks. Based on the assumption of (c) that those systems are consistent from its bearer's point of view, also the concepts used in such a network must allow interpretations that are consistent over the whole network. That means that it should be possible (1.) to map belief-value systems as consistent concept networks in a way that the used concepts define each other—like in a story where the meaning of terms can be understood, at least partly, based on its role within the whole; (2.) to identify certain structures and patterns within those concept networks, e.g., hierarchies, implications, causal relations, part-whole relations, surface and background structures; (3) to observe the development of those networks over time, that is to ask: Which new concepts enter the network? Are these concepts introduced as part of a reaction to an opponent's point of view? Are these concepts overtaken from an opponent and/or re-interpreted in a different conceptual network? Are concepts replaced by other concepts? Are there changes in the ways networks are structured?

Based on these assumptions, it might be possible to reconstruct the dynamics of a conflict as follows.

- Document the chronology of statements and other representations that form a network of interpretations and reactions;

- Code these statements according to the question whether they are intended to confirm or to criticize other statements;
- Identify the relevant concepts;
- Code the concepts according to the following criteria: Which are the pairs of concepts that are intended to oppose each other? Which concepts are intended to form mutually affirming cluster?
- Use bibliometrical methods such as content analysis (Krippendorf, 2004 <1980>) to analyze the chronology of statements and other representations based on the question whether patterns and trajectories are emerging;
- Map the outcome of the bibliometrical analysis on a time axis in a way that the self-organization of structures of mutually affirming clusters of concepts and statements becomes visible in contrast to other clusters;
- Try to identify overlapping structures. These can form “common languages” that can be used to reframe the conflict perception of stakeholders;
- Try to develop mathematical models that can be used to simplify the steps listed above, and/or to generalize the results in order to visualize patterns of conflict dynamics.

If such a reconstruction of conflict dynamics would be possible, we should get maps in which structures either organize themselves like laser beams, or form a more or less “fluid” network of changing relations. The hypothetical ends of those beams would form a “landscape” of attractors on which conflicting sensemaking processes converge at different points. By visualizing this attractor landscape, by reflecting on the processes that produce it, and by referring to possible common languages it should be possible to create new and exciting perspectives for conflict management.

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