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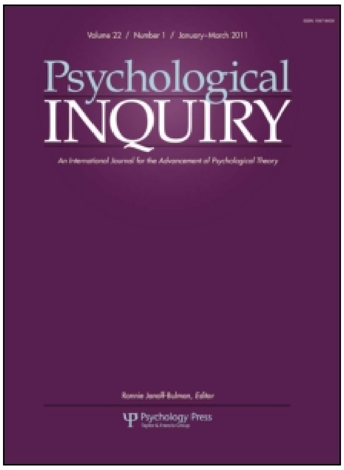

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COMMENTARIES

Requirements for the Emergence of a Dynamical Social Psychology

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In "The Emergence of Dynamical Social Psychology" Vallacher and Nowak make a plea for applying the concepts, methods, and tools related to the mathematical theory of dynamical systems to the field of social psychology. Because there is no easy entry point into studying social psychological phenomena, and because of the paucity of generally applicable theoretical concepts in this field, Vallacher and Nowak are to be appreciated for bringing this theory to the attention of their colleagues, as well as for seeking new venues for theory formation.

Vallacher and Nowak make a number of interesting connections between phenomena of interest to social psychologists and the properties of dynamical systems. These connections vary from analytically established correspondences between data and dynamical concepts (as in the mouse paradigm) to purely metaphorical images. However, formal models, in which dynamical models are shown to capture experimental data, are absent. This simple observation is indicative of the degree to which reality and theory have made contact with one another in this particular domain of research. What has emerged thus far is the promise of a dynamical social psychology rather than a new theory that has firmly established itself by mapping specific features of patterns of social behavior onto (low-dimensional, nonlinear, stochastic) dynamical models. This state of affairs is reflected in the virtual smorgasbord of concepts and tools borrowed from dynamical systems theory (DST) that Vallacher and Nowak present in their article—many, unfortunately, without any clear referents to the domain of social psychology.

Consistent with their portrayal of DST as a new scientific metatheory for social psychology, the authors seem to assume that all concepts and tools of DST can be usefully applied by social psychologists, and that theoretical progress will be the inevitable result of the sum of these applications. In contrast, we argue the position that DST by itself is not going to be a panacea uniting, in the authors' own words, the "fragmented field" of social psychology. As we hope to demonstrate in this commentary, the introduction of DST in social psychology requires a more rigorous theoretical embedding and harnessing of its basic strategic concepts than that provided by Vallacher and Nowak.

Collective Variables of Dynamical Social Psychology

To apply DST to social psychology, social psychologists will have to identify the key variables, parameters, and boundary conditions involved in the events that they seek to comprehend. Given a variable x whose derivative is some function of x itself (parameters, noise, etc.), what are the xs in social psychology? Without these variables, social scientists will be left with simulations and resemblances but, we fear, little progress in terms of scientific theory. In general, the choice of observables does not follow from DST qua mathematical theory but requires the adoption of a suitable theory of complex behavior in systems with many internal degrees of freedom.

To a degree, Vallacher and Nowak are aware of this problem, as is apparent from their discussion of order parameters. For this concept, they cite Landau and Lifshitz in the field of statistical thermodynamics. Although it is true that these physicists were the first to invoke the order parameter concept, there is good reason why readers of this discussion would be better served by its generalization to nonequilibrium physical, chemical, and biological systems, such as proposed in *synergetics*—the interdisciplinary approach to the study of self-organization formulated by Haken (1977, 1983). According to statistical thermodynamics and synergetics alike, the emergence of macroscopic order is entirely due to the dynamic interaction of the many microscopic degrees of freedom in the system. In biological systems, however, the path from the microscopic degrees of freedom to the macroscopic order is not as easily accessible as it is in physical systems. To give a (statistical) thermodynamical interpretation to the variables describing the macroscopic order in biological systems is quite impossible because the microcomponents of biological systems are much harder to define due to their heterogeneity and time-varying character. Therefore, the order parameter concept has received a more general meaning and operationalization in synergetics, in which the reduction of the order parameter to its constituent microscopic degrees of freedom is not a necessary ingredient of the theoretical strategy. Building on this more general operationalization of the order parameter concept, promising attempts can and have been made to capture the informational aspects of biological systems (e.g., Schöner & Kelso, 1988b).

Although Vallacher and Nowak vaguely refer to "some heuristics and more formal methods" that are available for identifying order parameters, they emphasize that "the search for order parameters is somewhat of an art." This is, of course, not a very reassuring starting point for social psychologists interested in seeking applications of DST. How does one go about identifying order parameters if no candidate variables are readily apparent? And, if one succeeds in coming up with a one or a few inspired guesses, how can one ascertain whether the selected variables do indeed qualify as order parameters? Unfortunately, Vallacher and Nowak give no satisfactory answers to questions such as these and thus fail to provide their readership with sufficient guidelines for applying the approach they advocate.

All might not be entirely lost for social psychology, however, if experiences in other branches of psychology and the brain sciences are anything to go by. For the last 2 decades or so, investigators have been quite successful in identifying order parameters and their dynamics using instabilities as a special entry point (for a review see Beek, Peper, & Stegeman, 1995; Kelso, 1995). In dynamic pattern theory/coordination dynamics, instabilities play both a conceptual and a strategic role. In complex systems many variables can be measured, but not all are relevant, instabilities demarcate one behavioral pattern from another, thereby allowing the investigator to identify the variables that best describe the observed change in pattern (i.e., the order parameters or collective variables).

The parameters that induce qualitative changes in behavior (i.e., in the order parameters), are called control parameters. Control parameters can be used to move the system through its collective states. In fact, this property is so essential that the broader definition of control parameters adopted by Vallacher and Nowak, in which external variables that produce only quantitative effects are included, should be considered unfortunate because it will not only lead to an underconstrained use of the control parameter concept, but also to an underconstrained use of its inseparable companion, the concept of order parameter itself. Order parameters and control parameters are the yin and yang of pattern dynamics (Beek et al., 1995; Kelso, 1995). You cannot be certain whether you are dealing with a control parameter unless its (continuous) variation causes qualitative change. Vice versa, you cannot be certain whether you have identified an order parameter unless it changes qualitatively as a result of (merely quantitative) changes in a control parameter.

Our point is that only when collective variables and control parameters are found, according to the strategies proposed in synergetics, do the formal tools and concepts of dynamical systems come into play, and only then can formal modeling attempts be undertaken. It is in this regard that we, unlike Vallacher and Nowak, do not view DST per se as a viable metatheory for psychology. A viable metatheory is provided by synergetics—strategically enriched with concepts that are well suited to deal with informational aspects of living systems as in dynamic pattern theory/coordination dynamics (Beek et al., 1995; Kelso, 1995). It is within the latter that DST receives its theoretical motivation. From this perspective, it is clear that mathematical modeling in terms of dynamical systems is not an end in itself. Rather, it is more important to establish whether the key concepts of pattern-forming systems, such as stability and instability, are valid in the first place. The challenge for the social scientist is to identify patterns of social behavior that can be meaningfully investigated in terms of their stability and instability, and to interpret the observed dynamic patterns (and their origin) in a manner consistent with the adopted (meta)theory.

Intrinsic Dynamics

In their attempt to come up with a theoretically meaningful interpretation of the dynamics of social psychological phenomena, Vallacher and Nowak emphasize that dynamical systems exhibit intrinsic dynamics, which they define as "internally generated patterns of change." Unfortunately, this unconventional definition does not follow from DST as such; it seems to be aimed at serving another theoretical purpose than that of understanding the stability properties of dynamic patterns, as in synergetics.

In the synergetic approach, intrinsic dynamics refers to those behavioral patterns that arise due to nonspecific changes in control parameters (Kelso & Schöner, 1987; Schöner & Kelso, 1988a). Much empirical evidence and theoretical modeling has shown that patterns of behavior may emerge and change without explicit prescription of these patterns. The observed patterns, that is, possess intrinsic dynamics, whether those patterns are generated within the organism, between the organism and the environment, and even among organisms themselves. Thus, intrinsic dynamics does not refer only to internally generated patterns of change as Vallacher and Nowak claim. The concept is much more general: The same equations of motion have been found to apply to systems with very different interiors in very different environments. All that is necessary to establish the concept of intrinsic dynamics is to find the pattern variables, or order parameters, and the control parameters. It is important to note, these control parameters do not "code" for the patterns, they simply induce pattern formation and change when they are varied. Likewise, control parameters are not only "external variables influencing the behavior of a dynamical system" but may also be of an internal nature, for instance, hormonal and electrical influences in the nervous system.

Notice also, although intrinsic dynamics is nonlinear, it does not only make "qualitative predictions of behavior." On the contrary, in a number of cases, the quantitative predictions associated with qualitative change in behavior have been confirmed in detail (e.g., Scholz, Kelso, & Schöner, 1987). It is clear that finding the nonlinear models and checking their quantitative predictions represents a major challenge to social psychology. A very different approach to the design and analysis of experiments is warranted to achieve this goal than is found in psychological textbooks. In the nonlinear paradigm, it is the sensitive dependence of key pattern variables on systematically changing control parameters that is of most interest. The statistical independence assumption between treatments (the independent variable) of conventional design and analysis of variance is not only invalid, it is against the spirit of the nonlinear approach (Kelso, 1990).

How Should Social Psychologists Proceed?

Although the work on movement coordination may give particular reason for optimism about the possibilities of a dynamical social psychology, we feel that the sheer complexity of social psychological phenomena calls for a more reserved stance in this regard than that adopted by Vallacher and Nowak. Because dynamical social psychology is concerned with behavioral patterns occurring in different situations, it will have to identify the situational properties that constrain the resulting behavior. The nature of the interactions between a person and his or her social environment may greatly complicate the fulfillment of this requirement. Contrary to nonliving systems, living systems, particularly human beings, have the ability to direct their attention, that is, to actively (intentionally) select or ignore information. Thus, they are capable of inducing changes in the dynamics of behavioral patterns by changing the information on which these patterns are based. In other words, instead of qualitative changes in the value of a single order parameter, qualitative changes in behavior may occur due to a shift from one order parameter to another. Because the resulting phase transition is essentially different from a phase transition induced by the continuous scaling of a (nonspecific) control parameter, it is important to be able to differentiate between the two—something that can only be accomplished in situations in which the intrinsic dynamics of an order and a control parameter has been identified.

Therefore, is there a way to uncover order and control parameters, and hence the dynamics, without a great deal of knowledge of the social phenomenon and without immediate opportunities to induce instabilities? Of course, one can make inspired guesses about relevant variables and use dynamical systems like logistic maps as metaphors for processes one does not understand. As Vallacher and Nowak acknowledge, however, the purpose of dynamical social psychology is to go beyond metaphor. After all, DST provides the conceptual and experimental tools to unambiguously identify the dynamical principles governing behavioral patterns. The question is, How can these principles be identified in social psychological systems? There are two options: by looking for instabilities and by studying stable solutions.

As mentioned earlier, instabilities offer important clues about the order parameters with which to describe a dynamic pattern. To find such instabilities, Kelso and colleagues (Haken, Kelso, & Bunz, 1985; Kelso, 1984) applied the synergetic strategy of inducing instabilities by continuously scaling a control parameter. The current lack of empirical knowledge about order and control parameters in social psychology constitutes an obstacle to applying the nonlinear paradigm in this field. One way to work around this problem is to "reverse engineer" this paradigm by looking for places where behavior changes abruptly (Kelso, Scholz, & Schöner, 1988). Candidate order and control parameters may emerge from such studies. Order parameters may be found by analyzing the switching times from one behavioral pattern to another, and control parameters may be found by analyzing the factors that were responsible for the observed changes. The latter have to satisfy two requirements. The first is that it must be clear that the control parameter contains no information specific to the behavior of interest, that is, it must not specify the behavioral pattern in any way. The second is that it must be scaleable across a sufficiently large range of values. Once such candidate control parameters have been identified, it must be determined experimentally whether abrupt changes in behavior can be induced through the continuous scaling of control parameters. If so, the order parameter will reveal itself, and defining criteria of nonlinear phase transitions (such as bimodality, divergence, critical fluctuations and hysteresis) can be tested for.

Stability characteristics may offer clues about relative stability in multistable systems, which social psychological systems are without question. A multistable coordinative pattern can be investigated by means of its stability characteristics. Switching times and dwell times are indexes of relative stabilities. In a system in which multiple stable patterns coexist, the dwell time is longer for the more stable pattern, and the switching time from a stable to a less stable pattern is longer as well. A prerequisite for such an analysis is that the observation time is longer than the equilibration time, that is, longer than the time it takes for the system to visit all stable states. Close examination of the stability properties of a specific social behavior may lead to hypotheses about possible order parameters for the description of that behavior that have to be tested later by inducing instabilities through the manipulation of a control parameter.

Presumably, these two approaches are most successful when a modest starting point is selected. A general recommendation to social psychologists is to concentrate on social situations and tasks that are simple enough to be easily accessible in experiments and complex enough to exhibit, in the most elementary form possible, dynamically meaningful (i.e., nonlinear) properties such as loss of stability and multistability. As demonstrated by Kelso and colleagues in their studies of bimanual rhythmic coordination, a relatively simple transition phenomenon may provide an ideal springboard for the investigation of more complex issues. In their original study, the relative phase between the moving limbs was identified as the order parameter to describe the observed transition from antiphase to inphase coordination that occurred when the control parameter movement frequency was gradually increased. A model was developed that captured the relation between the stability of relative phase and the frequency of movement (Haken et al., 1985). In subsequent work, this model provided a firm theoretical basis from which issues such as multifrequency behavior, transfer of learning, intention, perception–action patterns, symmetry breaking due to effector asymmetries, and even neural activities in the brain could be tackled.

Whether it will prove possible to develop similarly fruitful experimental research programs in the context of social psychology is an open question that will probably not be answered in the near future. In this commentary, we clarified why new theoretical concepts regarding the complexity of biological systems, such as provided in Haken's (1977, 1983) synergetics and extensions thereof in the study of human brain and behavior, are required to conceptually constrain applications of DST to biological, psychological, and social phenomena, and why concepts such as order parameters, intrinsic dynamics, instabilities, and multistability should not be treated casually. We hope that these points contribute to Vallacher and Nowak's most valuable and stimulating attempt to define a useful theoretical foundation for the development of a dynamical social psychology.

Note

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Dynamical Systems Theory and Social Psychology: The Promises and Pitfalls

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In "The Emergence of Dynamical Social Psychology" Vallacher and Nowak introduce dynamical systems theory (DST)[1] as a promising new model and methodology to resolve many of the theoretical and methodological problems afflicting social psychological research. They join recent writers in social psychology (Eiser, 1994) and the behavioral sciences (Abraham & Gilgen, 1994; Barton, 1994; Gottschalk, Bauer, & Whybrow, 1995) in issuing a clarion call to focus our attention on the promise of DST.

We are reminded by the authors that the exigencies of psychological research (e.g., funding and practical limitations) often result in focused, less ambitious research protocols that investigate one or two "causal" factors using traditional experimental methods. Vallacher and Nowak eloquently point out that the reductionism and parsimony ingredient in such research often results in forfeiting the meaning and purpose of a holistic understanding of human behavior. One of the promises of DST is its focus on the exploration and understanding of both local and global patterns of variability in psychological research, recapturing ground lost in more focused experimental designs.

A second promise of DST is conceptually reframing traditional causal factors into mediating forces. This powerful reformulation clearly finds historical precedence in social psychology and carries with it a "softer, gentler" ontology. Moreover, the breadth of methods introduced by Vallacher and Nowak for applying DST is impressive, ranging from computer simulations and laboratory analogues to more traditional field studies, opening up the promise of methodological diversity.

There is a provocative quality to Vallacher and Nowak's treatise that inveigles one to abandon current social psychological methods and adopt DST as the "new and improved" model of science. This appeal is further fortified by the persuasive theoretical and empirical examples offered. However, to the uninitiated, the intricacies of nonlinear dynamics may seem elusive even after finishing the authors' comprehensive treatment of DST. This state is understandable because it is impossible to provide enough background on DST in a single article (or even a book) for the general reader to adequately grasp the challenging conceptual and technical features of nonlinear dynamical analyses. A commentary such as ours is even further handicapped. Accordingly, we elected to organize our comments under three main headings: theoretical, analogue, and empirical applications of DST. Although these themes are interwoven in Vallacher and Nowak's discussion of DST, we believe that the salient issues relating to each are distinct enough to warrant separate attention. Because the empirical arena is the penultimate test of a theory in science, more detail is provided in this section, including a brief summary of the steps involved in an empirical application of DST. Moreover, our limited familiarity with the social psychological literature necessarily focused our comments primarily on methods and analysis.

Theoretical Application of DST

Vallacher and Nowak accurately point out that one of the most influential features of DST for theory construction was the realization that very complex and

[1]The reader should be aware that Vallacher and Nowak's use of the term DST includes the study of chaos and complexity theory. There is considerable debate regarding the definition of these theories (cf. Burlingame & Bloch, 1996; Horgan, 1995; Pool, 1989), and space limitation prohibits adequate treatment of the issues involved.