Psychodynamic Formulation in the Age of Neuroscience:
A Dynamical Systems Model

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The dichotomy between biological and psychosocial psychiatry has stood as a deep divide in psychiatric treatment and training since the advent of psychoanalysis. It is now complicated by the proliferation of diverse theoretical perspectives, both psychotherapeutic and neurochemical. Our deepening understanding of neural network dynamics can provide empirical constraints in validating psychotherapeutic approaches, while the appreciation of the patient-therapist intersubjective matrix can inform biological treatment. The Cartesian mind-body fallacy can now be analyzed as a unified complex dynamical system in the same light as Einstein’s integration of the seemingly divergent concepts of space and time into a unified fabric of spacetime.

Dynamical systems approach to neural network functioning offers the most comprehensive foundation for psychotherapy available to us today. Recurrent patterns of thinking, feeling, and relating can be analyzed by modeling the dynamical landscape of cortical and subcortical network processes. Dynamical Systems Therapy (DST) stands as a trans-theoretical model with the explanatory power to integrate systems of synaptic networks with systems of meaning. It powerfully argues for shifting the clinical emphasis from our patient’s symptomatic presentation as the focus of clinical attention to conceptualizing psychopathology as fixed patterns of adaptive attractors in response to the dysfunctional developmental environment. Patients come to be seen as active agents who create the meaning of their experiences based on their unique implicit templates. In this view, DST-informed psychodynamic formulation helps us chart the patient’s dysfunctional attractor basins, and therapeutic relationship becomes our tool in reshaping the dynamical landscape topology to reestablish self-organizing process.

INTRODUCTION

Conceptualizing the etiology of a clinical syndrome and diverse factors contributing to it is the cornerstone of medical practice. The process can be complicated enough with somatic disease, but it can get intractable in psychiatric illness, where both “objective” clinical data and subjective experience need to be considered.

The Cartesian fallacy of mind/body duality, and the consequent conceptual chasm between psychoanalytic subjectivity and the “third-person” neuroscience perspectives, has divided the discipline of psychiatry for over a century. The advance of the “managed care” era further polarized

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the field by driving the demand for “evidence-based” treatments and eschewing the patient’s unique individuality in favor of manualized approach. Indeed, it can be tempting to reduce the enormous complexity of the patient’s life experiences by retreating into the relative comfort of our “objective” theories, or assuming the role of an “independent observer” in clinical interactions. Yet, lessons from the greatest scientific breakthroughs of the last century teach us that the seemingly divergent concepts of space and time, matter and energy, are dual aspects of the same underlying reality, of which conscious observers are an integral part: the position of an “independent observer” is only a convenient fiction (Bohm, 1992).

In psychiatry, just as in contemporary physics, the illusion of objectivity comes at a high price: we may end up reducing our patient’s unique individuality to a manualized list of symptoms, and build a contemporary Tower of Babel, where members of diverse approaches lose sight of the patient’s experience for the trees of their theories. According to recent estimates, the number of possible synaptic firing patterns in the human brain exceeds the entire number of atoms in the observable universe by a factor of 100 (Edelman, 2004). If we stay with the scientific assumption that our memory and subjective experiences are encoded in the dynamic patterns of cortical synaptic network activity, the degree of complexity we are facing in everyday clinical interactions vastly exceeds the computational capacity of even the most advanced supercomputers available to us today.

How do we integrate the psychodynamic emphasis on subjective experience with the advances in neuroscience? How do we avoid the pitfall of putting a suffering human being in the box of our theories and applying statistical manuals to her—rather than trying to understand the person sitting in the patient’s chair? And how do we teach such integrated approach to the next generation of trainees so they are not faced with the choice between biological or psychodynamic “camps” to their own and their patients’ detriment?

The aim of this paper is to provide a conceptual bridge between the patient’s “first-person” subjective experience and the therapist’s “third-person” observational vantage point based on the language of complexity theory. This would allow psychodynamic clinicians to create a comprehensive case formulation that effectively eschews brain/mind dichotomy in favor of a rigorously scientific clinical assessment that incorporates both psychodynamic and neural network aspects of individual experience. The model is operationalized as Dynamical System Therapy (DST).

This paper focuses on applying the DST approach to creating a comprehensive psychodynamic formulation, a four-stage format that can be used in psychodynamic therapy assessments and teaching integrated psychodynamic/neuroscience approach to graduate students and psychiatric residents. It is the goal of a subsequent paper to look at the therapy applications of the DST model.

WHERE WE STAND TODAY

There is scarce literature on integrating biological and psychodynamic schools of case formulations. Perry, Cooper, and Michels’s (1987) attempt to formalize psychodynamic formulation, and subsequent elaboration by Summers (2003) stand as seminal papers in the field. Weerasekera (1993) outlined a “multiperspective model” integrating individual and systemic factors in several dimensions. Other recent attempts include Gordon and Riess’s (2005) “collaborative conversation” approach, Sperry et al. (1992), and Kassaw and Gabbard’s (2002) comprehensive reviews of the field, and of attempts to integrate psychotherapy and pharmacokinetics.

One difficulty psychotherapists face in the United States is the formulation of overarching theories that can accommodate their diverse practice. The long-term goal of the project is to develop a novel model of human behavior that integrates psychodynamic, neurobiological, and environmental influences on behavior.

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of the field, and Mace and Binyon’s (2005) four-level teaching model. There have been a number of attempts to integrate the recent advances in neuroscience with relational psychoanalytic theory (Beutel et al., 2003; Levin, 2006) and with mainstream psychiatry (Etkin, Pittenger, Polan, & Kandel, 2005; Spitzer, 1995), but these have not dealt specifically with the issue of case formulation.

One difficulty that becomes apparent on reviewing the literature is the great divide between psychotherapeutic and biological orientations, with less obvious but often equally deep chasms between various psychotherapy schools. Eells (2006) edited a state-of-the-art Handbook of Psychotherapy Case Formulation, where the richness and complementarity of the diverse approaches contrast with the sheer alienation between them. We are besieged with dichotomies awaiting their dialectical resolution: psychotherapy versus psychopharmacology, CBT versus psychodynamic approaches, one-person versus two-person psychologies. The situation in the field resembles a Woody Allen’s hypochondriacal character in Hannah and Her Sisters” (1986), who goes from one religious authority to another in the fruitless search for the meaning of life.

The integrative psychotherapy movement (Anchin, 2008; Gabbard & Kay, 2001) has gone some way to bridge these conceptual gaps, but the languages of neurobiology and psychodynamics remain as far apart as ever. Yet, this seeming incompatibility may be only superficial, resembling the situation in physics at the turn of the last century. To quote Gabbard (1994), “Just as the physicist must simultaneously think in terms of particles and waves, the psychiatrist must speak of motives, wishes, and meanings in the same breath as genes, neurochemistry, and pharmacokinetics” (p. 428).

The long-standing nature–nurture debate can serve as an instructive case. The recently completed Human Genome Project identified far fewer genes (less than 25,000) than was previously anticipated, only 15% higher than in a common flatworm (Stein, 2004). This number is grossly insufficient to account for the complexity of human behavior. We know now that genes are not a set of fixed inherited markers that rigidly determine our capacities and vulnerabilities. Advances in epigenetics (Jaffee & Price, 2007) demonstrate that genes flexibly turn on and off depending on the organism’s internal state and environmental demands, with particular sensitivity to early developmental interactions (Weaver et al., 2004). The individual genotype therefore behaves as a fluid reservoir of information that our bodies continually tap into in the process of adapting to the changing environment, which in turn has a lasting imprint on gene expression. The question today is not whether a specific psychiatric syndrome is due to nature or nurture factors, but how a patient’s unique developmental environment may have influenced his or her unique inherited predispositions and vulnerabilities.

Psychoanalytic practitioners seek to understand key developmental and relational patterns that may have predisposed the patient to develop psychiatric illness, precipitated its onset, and continue to perpetuate its course. These patterns can be analyzed and treated on the behavioral level (such as maladaptive relational scenarios), but it is often the patient’s subjective meaning and emotional experience of the events that separate mental health from psychopathology. There is an apocryphal story of a violent rape victim (B. Van der Kolk, personal communication, 2009) who was able to return to reasonably normal functioning with supportive counseling, until 3 months after the event when she read that her rapist was finally caught—after mutilating and killing his next victim. She developed intractable PTSD from that point on. As clinical practitioners, we have to appreciate that our patients are not just passive recipients of their life events but rather actively construct the meaning of their experiences.
How can we ever hope to quantify subjective meaning in neurophysiological terms? Antonio Damasio (1999) and Nobel-prize-winning biophysicist Gerald Edelman (2004) offered a promising beginning by differentiating between primary, secondary, and tertiary neural network assemblies underlying human awareness. Primary networks are a basic property of any living system: they monitor the organism’s immediate environment and allow for reflexive action—an amoeba withdrawing from hypertonic solution, or a child pulling her hand from a hot stove.

Secondary networks monitor changes in the primary networks following an environmental exchange. They allow for primary consciousness, such as basic awareness of pain in the burned hand, which is accessible to both humans and animals. The common experience of a “driver’s fugue” is one example of human consciousness being limited to the secondary systems. We may suddenly realize that we have driven a considerable distance without any awareness of keeping our eyes on the road or our hands on the steering wheel—yet we have successfully negotiated a complex behavioral sequence as evidenced by the fact that we are still able to reflect on the matter!

Tertiary networks, in turn, monitor changes in the secondary networks over time; they allow for reflective consciousness, or awareness of being aware. It is here that we find the faculties of hindsight, insight, and foresight; higher social functions of emotional awareness and extended empathy; and emergent properties of free will and meaning—the capacities that distinguish us as Homo Sapiens Sapiens. Tertiary networks are based in the higher associative cortical areas that integrate sensory, interoceptive and emotional information, such as cingulate, prefrontal/orbitofrontal, and temporo-parietal cortices (Lieberman, 2007).

THE DYNAMICAL SYSTEMS MODEL IN PSYCHIATRY

Technological intuitions of the time have shaped our understanding of psychological phenomena for centuries. We no longer think of the brain as the cooling system for the blood, but some of our clinical interventions are still influenced by the 19th-century steam engine model, with its hydraulic drives and release of internal pressures. Nor is the 20th-century computer metaphor, with its CPUs, RAM, and hardware/software analogies, any more adequate in view of the findings from contemporary neuroscience (see Table 1). The human brain behaves as a complex, adaptive, self-organizing system arranged in parallel distributed neural networks, where functional differentiation is coupled with flexible integration of neuronal components, and continually changing patterns of activity compete for access to consciousness (Edelman, 2004).

Complexity theory (Mitchell, 2009) has emerged in the past decade to shed light on diverse and seemingly intractable phenomena, from weather patterns to neural network assemblies to stock markets and social dynamics, with relevant applications to psychotherapy process. It captures the behavior of nonlinear dynamical systems (NLDS), where the system’s output is not always proportional to the input because gradual changes in the subsystem parameters lead to discontinuous, qualitative changes in the systemic behavior. Evolutionary process itself could be one example of NLDS, as in the current consensus that periods of gradual adaptation alternate with periods of abrupt evolutionary change (punctuated equilibria; Gould & Eldredge, 1993). In the most general terms, complexity paradigm describes the systemic emergence of order out of local interactions; it is based on information processing in dissipative (open) systems and is equally applicable to "objective" neural network dynamics and subjective experience, such as perceptual and meaning categories.
TABLE 1

<table>
<thead>
<tr>
<th>Classical Psychodynamics</th>
<th>Dynamical Systems Therapy</th>
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<tr>
<td>XIX century thermodynamics paradigm: therapy involves rechanneling instinctual drives</td>
<td>Interactive neural networks paradigm: therapy involves modifying dysfunctional templates and</td>
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<td>“internal pressures”</td>
<td>creating more adaptive attractor/repeller systems</td>
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<td>Predictable linear causality: patient’s symptoms resolve when her conflicts are</td>
<td>Nonlinear dynamics: exact trajectory of the patient-therapist system is unpredictable from</td>
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<td>analyzed by a trained therapist</td>
<td>the initial conditions</td>
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<tr>
<td>Therapist as an “objective observer”: classical Newtonian paradigm</td>
<td>Therapist as an integral part of the system (quantum mechanical paradigm): “dynamic, dyadic,)</td>
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<td>intersubjective systems” (Stolorow, 1997)</td>
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<tr>
<td>Patient as a victim of her illness or developmental trauma</td>
<td>Patient as an active creator of her subjective meaning and interpersonal reality</td>
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<td>Therapist as a “blank screen”</td>
<td>Therapist as a co-creator of intersubjective meaning</td>
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<td>Therapist’s role is to “fix” the patient: medical model paradigm</td>
<td>Therapist’s role is to tune the topology of the dyadic system to reestablish self-organizing process</td>
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One important parameter of NLDS, which applies to biological systems, is that they straddle the narrow domain between linearity and chaos. Linear laws describe deterministic “classical” Universe, where a system’s behavior can be calculated with any degree of precision for an arbitrarily long period of time. They leave no space for purpose, intentionality, or free will within the domain of natural law.

By contrast, NLDS behavior is not completely described by the behavior of its constituent parts but tends to display emergent qualities, where systemic outcome is greater than the sum of its parts (e.g., the properties of liquidity or wetness when large numbers of H₂O molecules are assembled together). In addition, the functional elements in such systems do not remain stable over time: changes in one component continually affect changes in others. Consequently, NLDS are characterized by extreme sensitivity to initial conditions, which makes the task of predicting their future trajectory a practical impossibility because doing so would require us to specify the initial parameters with infinite precision (in the case of patient-therapist systems, this is a fact that any experienced therapist is painfully aware of). The problem of predicting even a relatively simple outcome, such as the trajectory of planets orbiting a star system, already becomes mathematically intractable when more than three interacting components are at play (cf. Henri Poincare’s 3-body problem). By contrast, in the adult human brain we are dealing with over 30 billion functional components in the cortical areas alone (Kandel, Schwartz, & Jessel, 2000).

And yet, as part of our daily lives, we routinely perform nonlinear computations that are far more complex than any supercomputer could accomplish today (consider a hockey player who successfully sends a puck into the net shortcutting a myriad of potential nonlinear interactions). Our brain does this by utilizing “fuzzy logic,” or implicit pattern recognition. Psychodynamic clinicians are highly skilled at identifying such “fuzzy patterns” and bringing them to consciousness, thereby allowing the patient’s tertiary meaning networks to modify his or her dysfunctional patterns. There are several excellent papers exploring therapeutic implications of the complexity model (Coburn, 2000; Palombo, 2008; Seligman, 2005), which has the potential to transcend the
deterministic constraints of reductionist science. In the words of Spruiell (1993), “If psychoanalysts pay attention to what they actually do within the analytic frame, they will regain hope and a measure of freedom from the older constraints of obsolete and narrow . . . ‘clockwork Universe’” (p. 33).

NLDS behavior is defined by several parameters. The first and most important to consider is the concept of attractor states. Even though the system’s outcome can never be calculated precisely, its trajectory follows predictable patterns, which can be modeled and observed. Both linear and nonlinear systems gravitate to their lowest potential energy states in the absence of external force. A pendulum will eventually point to the Earth’s center of gravity (point attractor); human sleep-wakefulness cycle shows a pattern of diurnal variation (periodic attractor). NLDS follow more complex attractor patterns, some of which can be represented by topological shapes (e.g., toroids), and some that cannot be described by simple geometrical figures (this is the category of strange attractors) that often, describe the behavior of chaotic systems; see Figure 1). Such attractor states can be visualized as a path that a bee would take in flying from one flower to the next. The trajectory is not direct, with many seemingly random starts and stops, and a unique pattern that will never be precisely repeated again—yet we can reliably predict that the bee will eventually settle on a flower.

Human behavior and cognitive processing follow a remarkably similar paradigm. You may not be feeling hungry as you are reading this page, but you will experience hunger sometime today. You will eat something (bee landing on a flower) but you cannot precisely predict what, where, and when. Even if you made a specific plan of meeting a friend for fettuccini at your favorite Italian café at 6 p.m. tonight, your trajectory of getting there is going to be unique and unpredictable, never to be repeated again (it also goes without saying that you will not be there precisely at 6:00).

All of us have a complex set of implicit attractor states that shape our choices, often outside of conscious awareness. If you ask yourself, “What would I like to do tonight”—you may be aware of running through imaginary scenarios in your mind, matching the possibilities to your particular set of preferences, and monitoring the corresponding emotional reaction. In a way, you are selecting the “lowest energy state” given your current physical/emotional condition and your

![Graphic 3-D representation of a complex (strange) attractor](color figure available online).

**FIGURE 1** Graphic 3-D representation of a complex (strange) attractor (color figure available online).
important to consider is that be calculated preserved. Both linear absence of external it attractor); human tors. NLDs follow logical shapes (e.g., this is the category see Figure 1). Such m one flower to the stops, and a unique ict that the bee will paradigm. You may e hunger sometime cisely predict what, er fettuccini at your ng to be unique and ou will not be there ices, often outside right—you may be possibilities to your action. In a way, you l condition and your underlying likes and dislikes, which is evidenced by the inner feeling of satisfaction when you settle on the most attractive option. The outcome may seem unique for every reader and every choice, but each of us cannot help but follow a pattern: the comforting choice for an introvert may be to settle down with a book by a fireplace, while an extrovert would prefer a social gathering. But an exhausted extrovert may still opt for a restful evening at home.

A system's entire set of attractor states can be visualized as a series of basins, or valleys, in a mathematical phase-space, called adaptive landscape (A-landscape; Figure 2). The basins represent the states of lowest energy, where the system will have the greatest probability of settling down. A physical analogy would be to place a heavy object on a trampoline, thus creating a gravity well that pulls other objects to the bottom and makes it more difficult to "climb out of it." Conversely, our mathematical A-landscape also has hills, or ridges, which represent high-energy states where the system is less likely to be found.

The same model can be used to map a person's psychological space. Of course, there is no gravity in psychological space, but our habits and preferences hold us in similar ways, making it more likely that our behaviors will settle in familiar and comfortable attractor basins. These attractor states also create what we experience as resistance to change: how many clinicians have had an experience of repeatedly advising an obese prediabetic patient to engage in regular physical activity and monitor her diet—only to be faced with more weight gain on the next visit?

In exploring individual behavior, A-landscape model represents the full range of potential choices that we make in our lives, both conscious and unconscious, personal and relational, professional and private. This is the principle underlying DST, which flexibly incorporates our systemic "life trajectories" on multiple levels. Ultimately, dynamical systems approach deals with information about the system and its components (in this case, the patient and any factors that affect his or her choices) rather than "material" brain or "immaterial" mind, with problematic interactions between them. Therefore, Cartesian dichotomy does not apply within the DST model, where it makes no difference whether we are dealing with the third-person perspective (behavioral observations or changes in neuronal activity on fMRI)—or individual fantasies, feelings and desires (first-person subjective perspective). In addition, both conscious and unconscious choices
fall within the DST domain because both can represent our choices shaping the systemic life trajectory.

The picture of psychopathology arising from DST has less to do with “deviance” or “resistance” but rather with habitual “lowest energy states” that the patient implicitly follows, often to his or her own detriment. The term “energy” in this case does not relate to caloric expenditures, as in the case of an anorexic addicted to compulsive exercise. Both a prediabetic “coach potato” and anorexic “exercise addict” display a pathological attractor that influences their choices, and these attractor states need to be mapped and modified in the course of DST-guided treatment. One clinical example is “battered wife” syndrome, where a woman may go from one abusive partner to the next without stopping to pay attention to the cycle. Such choices are often driven implicitly, therefore bringing dysfunctional attractors to consciousness and exploring the patient’s investment in them is one of the primary modes of intervention within the DST framework. The primary question in DST treatment becomes, Why do we do what we do?

An individual’s A-landscape also contains peaks, or repellors, representing choices or activities that we tend to avoid. For instance, a vegetarian may have several attractor basins for her favorite foods, but in all of them there is going to be a repellor hill representing the choice to stay away from meat. These repellors are not absolute—a vegetarian may resort to meat if no other nutritional choices are available. Nevertheless, it is far more likely that a vegetarian will make non-meat food choices in most settings. Similar patterns apply to daily choices that we make in our lives—from religious preferences, to cultural stereotypes, to sexual roles, to personal likes and dislikes. One clinical example of repellor dynamics is phobic reactions, where a patient will stay away from an object or activity because of intense anxiety associated with it.

We have now arrived at the picture of a complex, three-dimensional landscape unique to every individual, the proverbial “map of the mind,” with its valleys and peaks representing our likes and dislikes, and a complex network of interconnected attractor basins where we find the highest probability of our life choices flowing under normal circumstances. The real complexity, however, arises from the fact that our psychological A-landscape is not a fixed configuration that our genetic makeup or life experiences have dealt to us. In keeping with the nature–nurture analogy, psychological attractors and repellors are dynamic constructs: they change in the course of individual development and ongoing adaptation to our environment, just like canyons that are gradually deepened by a water stream over geological time scales. In neural network terms, our experiences carve out functional synaptic pathways in accordance with Hebb’s rule: “Neurons that fire together wire together.” This is the process that Gerald Edelman named experiential selection, or “neural Darwinism”: viable neural networks are selected and modified based on the ongoing input from our environment. These adaptations and learning, or in DST terms the information we process in the course of our lives, literally shape the microstructure of our brain: attractor basins gradually deepen and transform into a complex network of channels and tributaries representing habitual lifestyle choices we make over time. Repellor hills grow into mountain ridges, which under normal circumstances we are reluctant to climb.

In addition, both within our psychological space and synaptic networks in our brain, the attractor valleys can grow deeper or shallower over time, such as a committed relationship growing out of a blind date (a gradually deepening attractor), or a career change (a previously deep attractor channel growing shallow). The entire scope of individual development can thus be visualized as a complex pattern of gradually evolving and dissolving attractor/repellor configurations that define our unique in stamps to set
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our unique individuality, from making friends to choosing a romantic partner, from collecting stamps to settling on a career (Thelen, 2005).

Recall that NLDS straddle the boundary between rigid linearity, on the one hand, and chaos, on the other. Consequently, in the DST view, psychopathology can be defined as a dialectic between rigid/inflexible fixed attractor systems vs. disorganized sets of chaotic attractors. Both limit the adaptability of the patient’s “self” system (Galatzer-Levy, 2004) and may result in intrapsychic and relational dysfunction.

One example of a dysfunctional fixed attractor system is the heterogenous class of addictive disorders, where patients feel unable to resist the pull of a self-destructive behavior, and repeatedly “give in to it” to their detriment. Another example can be found in obsessive-compulsive disorders, where patients repeatedly engage in compulsive behaviors in order to alleviate obsessional anxiety. An abuse victim’s cycle of going from one abusive partner to another also falls into this category. On the opposite end is the category of fixed repellor systems representing situations that patients tend to avoid; these include phobias, which can be especially problematic when the behavior in question is an important part of healthy functioning (in the words of one such patient: “I don’t do intimacy”).

Chaotic attractors are most clearly evident in patients with psychotic and dissociative disorders. Just like the behavior of chaotic systems appears to follow no discernible pattern, psychotic patients often present in “randomly bizarre” ways to an unsophisticated observer. Yet each patient’s psychotic behavior follows its own underlying pattern, a strange attractor that manifests itself in consistent paranoid or manic content, which is frequently stable and predictable from one episode to the next (in fact, such predictable patterns are often used to educate patients and their families in identifying future episodes).

We can easily see that an object moving along the A-landscape (see Figure 2) is affected by its initial conditions, the local topography of the system, and the rate of the landscape change. In psychological space, these factors represent the patient’s family of origin environment, biological/developmental vulnerabilities versus protective factors, and adaptation process to the changing environment. Since the patient’s present environment by definition includes her therapeutic milieu, informational input from therapy (including its cognitive, emotional, and relational aspects) will have the power to modify the original attractor/repellor landscape.

As we mature, there is an added factor of intentionality introduced by the tertiary meaning networks. For example, we can choose to forego a comfortable attractor basin to attain a personal goal (such as spending a night on call). We can also choose to “climb” a repellor system (such as rushing into a burning house to rescue a child), though the more “steep” the repellor configuration—the more willpower it is going to require to move towards it. Within the DST framework, this intentionality stance can be summed up by the maxim: “We choose what we do” (it serves to remember that most of our choices are implicitly driven).

The second parameter of NLDS with major therapeutic applications is the process of bifurcation. Bifurcations occur when the system shifts from one attractor/repellor configuration to another, usually in an abrupt and unpredictable way. Living systems, including the human brain, are not “locked” into static linear modes but oscillate between periods of incremental, quantitative microadaptations when they are in a state of near-equilibrium with their environment versus abrupt qualitative shifts when environmental demands exceed the system’s capacity to adapt (far-from-equilibrium condition). In complexity terms, these processes correspond
to first-order change (linear cumulative adaptation) versus second-order change (nonlinear system-wide shifts; Frigogine, 1997).

Because biological systems are dissipative (open to exchanging energy and information with their environment), internal organization is perpetually influenced by the external information input, and in turn, changes in the system's internal organization affect its interaction with its environment. Therefore, even though spontaneous internal fluctuations are possible, an open system is always part of a larger systemic whole and cannot be understood in isolation from it.

These complexity concepts correlate remarkably well with the clinical experience, particularly the relational psychoanalytic perspective. As any experienced therapist will attest, months or even years of therapeutic effort may produce little change—only to culminate in a "light bulb moment" of lasting change that heralds a qualitative shift, apparently in response to a trivial interpretation when the patient's system is ready to reassemble in a new configuration. Clinical literature is replete with such examples, from the Boston Change Process Group's "moments of meeting" (Lyons-Ruth & Boston Change Process Study Group, 2001), to Yalom's (2008) "awakening experiences" as opposed to the linear "life-as-usual" paradigm, to the conventional wisdom of an addict having to "hit the rock bottom" before changing her ways.

From this perspective, bifurcations in clinical practice can represent the process of creating new, more functional attractor/repellor systems through modifying the original A-landscape with the informational input from therapeutic interaction. This process is fundamental to any psychotherapy approaches where patients learn to see themselves as the common denominator in their predicaments, and work on changing the way they relate to the world and others around them (Ghent, 2002). Therapy, in the DST view, serves to help the patient understand the attractors/repellors inherent in their particular cycle, and not only "fence off" the dysfunctional precipices (such as avoiding alcohol indefinitely within the 12-step model) but potentially reverse the polarity of what is attractive, creating a more adaptive attractor landscape. In the words of one such patient, looking back at her roller-coaster relational style prior to therapy, "It just doesn't appeal to me anymore." Given successful therapeutic experience, such a patient may find herself a stranger in her old dysfunctional world (George Bernard Shaw's Pygmalion comes to mind as a literary analogy).

Unfortunately, bifurcations can also perpetuate dysfunctional intrapsychic and relational dynamics. One example of chaotic intrapsychic bifurcations is the spontaneous emergence of new alter states in a dissociative identity disorder patient. Such shifts can be precipitated by both external triggers, such as a hospital admission, and internal events, such as emergence of new traumatic memories. Another example of chaotic relational bifurcations can be found in a borderline patient, who perpetually shifts from conflictual family interactions to dysfunctional relational cycles to intense affectivity about routine interpersonal encounters.

The final parameter of NLDS to consider for the purpose of this review is the concept of self-organization (Kaufman & Clayton, 2006). Self-organization refers to spontaneous emergence of new orderly configurations in complex dissipative systems when they are driven away from equilibrium with their environment. Self-organization can be observed on multiple levels, from physicochemical to biological to social to economic systems. The key to self-organizing processes is that they are not preprogrammed or controlled from outside of the system, but represent global reordering that arises out of the local interactions among the system's subcomponents in far-from-equilibrium conditions. Pattern recognition in neural networks is one example of such process (recall a familiar visual illusion of shifting from seeing candlestick vs. 2 faces). Neural networks indeed have the capacity to adapt between different processing regimes.

While the learning system operates one's capacity for adaptability and becomes more complex in parallel, governed by the principles of self-organization but arising from different environments. It could be argued that the intrapsychic and psychodynamic catalysts! symmetrical but provocative reestablish their lives. What are the metaphors of the process? "terra incognita" an exploratory subject symptom dysfunctions in this approach to topographical and relational analysis.

In this section, we will summarize the key concepts:

**Step 1:**

**Patterns synaptic connections**
networks in the human brain do not follow a preprogrammed course but self-assemble as a way of adapting to one’s environment. This process accounts for the fact that any two brains, even between identical twins, are uniquely different, which provides the foundation for our unique self-experience.

While the incremental first-order change processes go on all the time (they represent everyday learning and microadaptations), second-order qualitative change only becomes possible when the system operates in the far-from-equilibrium conditions, when environmental demands far exceed one’s capacity to adapt. At this point, the system becomes destabilized, free to bifurcate into new adaptor/repellel configurations and reassemble in a more adaptive state. Rigid attractors soften and become more amenable to change. Chaotic attractors reorganize. A qualitative shift occurs. In parallel with the process of epigenetic neural development, nonlinear changes in therapy are governed by experiential selection—the patient’s capacity to reorganize his or her experience of themselves in relation to the world around them. This capacity is not imposed from outside but arises as an emergent property of the patient’s self-system in response to the new relational environment and the therapist’s input.

It could be argued that one of the primary functions of therapeutic interaction is to reestablish the patient’s self-organizing capacity, which may have been blocked by developmental, intrapsychic, or relational adversity (Siegel, 2006). One important point of similarity between psychodynamic and DST approach is that as therapists, we do not “cure” our patients but act as catalysts to enable their self-organizing process to take place. Just like we do not grow children but provide optimal environment for their growth, we do not fix our patients but enable them to reestablish their self-organizing capacity and help them make the changes they need to make in their lives.

What are the clinical applications of the A-landscape model? This approach allows us to draw a metaphorical “map of the mind” unique for every patient, a visual representation of the uncharted “terra incognita” of the patient’s lifelong subjective experience. Each clinical interview resembles an explorer’s voyage, charting the layout of the hereto-unknown land. Instead of being lost in the subjective domain of the patient’s inner world or trying to reduce it to a list of behavioral symptoms and manualized techniques, we can use the DST model to navigate the tributaries of the dysfunctional attractor/repeller systems and explore the patient’s investment in them. After using this approach for a number of years, this writer has come to visualize his patients’ E-landscape topography as a map to guide therapeutic interventions, and would feel blinded without the DST paradigm.

INTEGRATED CASE FORMULATION

In this section, a revised psychodynamic formulation incorporating advances in epigenetics and dynamical systems theory is proposed as a trans-theoretical integrative template. This format is summarized in the addendum, which can be utilized as a teaching tool.

Step I: DETERMINING ATTRACTOR TYPE

Patterns of thinking, feeling and relating represent attractor states based on the patient’s unique synaptic network configuration encoding her life experiences.
From the DST perspective, the primary goal of history taking is to identify persistent dysfunctional patterns (attractor and repeller states) in the patient’s life that will be the focus of therapeutic intervention. In so doing, we map the pathological attractor type on the patient’s A-landscape, identifying her problem basins and hills, as well as any areas of strength that we can build on. Consider where the patient consistently gravitates to in the following domains:

- Patterns of experiencing self-in-the-world (mastery vs. inadequacy)
- Patterns of experiencing self-with-others (intimacy vs. isolation)
- Patterns of self-experience (meaning vs. despair)

Case Vignette I:

L.L., a high-functioning 54-y.o hospital administrator leaves work due to a “burnout” after being harassed by her male supervisor, and responding with repeated attempts to “make it work” by being on-call 7 days a week for over a year. Her psychiatrist subsequently advises her to move away from her city of residence because of threats from her estranged homicidal husband. She now lives with a distant acquaintance in a different part of the country — exhausted from cooking, cleaning the house, and looking after the friend’s family and not looking after herself in spite of presenting with severe depressive symptomatology. On assessment, she insists on going back home to take care of her abusive ex-husband who recently had a mild MI.

Labeling this presentation as major depression or dependent personality disorder would be factually correct but fundamentally unsatisfying. As Irvin Yalom (2008) wrote in “When Nietzsche Wept,” “What matters is not the . . . appearance of symptoms, but the meaning of a symptom.”

The basic question for psychodynamic inquiry becomes: What is the pattern and why does the patient continue to engage in it today? In DST terms, we have to formulate a dynamic hypothesis by asking ourselves: “What attractor states underlie the patient’s habitual choices?” Here is the clinical exchange that followed (note that this is not a therapy but initial assessment session):

Therapist: “Is this a familiar place for you?”
L.L.: “What do you mean?”
Therapist: “You seem to be taking on the role of a slave wherever you go”
L.L.: [Freezing and staring as if slapped—then breaking down crying]: “This is what we were . . .”

There is a clear parallel here between psychodynamic and DST approaches: in psychodynamic terms, we could be talking about repetition-compulsion of significant developmental traumatic configurations. But DST model can also help us link this subjective perspective to the third-person neuroscience view and come up with a “dual aspect” synthesis. To illustrate, attractor states represent implicit templates (“self” in relation to world/others bound by the lasting affect), which are encoded in the synaptic configurations established in the course of developmental “experiential selection.” These synaptic networks continue to organize the patient’s information processing, shaping her present-day behavior. The relevant relational patterns are therefore a demonstration of the underlying attractor states, in this case—a “slave basin.” When such attractor patterns are brought to consciousness, they often trigger associated traumatic affects that can be processed in the course of psychodynamic treatment. Awareness of the implicit attractors, in turn, allows for the pattern...
for the “intentional stance,” providing the patient with a choice to change not only her relational patterns but also the way she organizes her self-experience on multiple levels.

Step II: DETERMINING ATTRACTOR SHAPE

Dysfunctional patterns and symptoms are not problems in themselves: they represent the patient’s (imperfect) adaptations to the adversities she has encountered in her developmental environment.

Once the relevant attractor systems in the patient’s A-landscape are identified, we need to determine the origin and progression of these patterns in the course of the patient’s life. In so doing, we chart the attractor shape on the patient’s A-landscape (i.e., configurations and layout of the pathological attractor channels and their tributaries). This is the process of epigenetic analysis, or mapping developmental “nurture on nature” interactions, to arrive at a dialectical integration representing the patient’s life experience.

Nature:

- Temperamental predispositions (e.g., harm avoidance, reward dependence, novelty seeking; Cloninger, 1994)
- Biological vulnerabilities (birth complications, impact of medical/learning problems, brain injury)
- Family history

Nurture:

- Family of origin environment, including adoption, parental fit/availability, sibling position
- Relational experiences (peers, authority, significant others)
- Developmental trauma (early hospitalization, physical/emotional/sexual abuse, normative/cumulative micro-trauma, neglect; Van der Kolk, 1996)
- Cultural background and beliefs

Synthesis:

- Hypothesis of nurture-on-nature: How did the patient end up where (s)he is?
- Identifying the core dysfunctional attractor system (cf. central dynamic theme): current problems as tributaries leading back to the main pathological attractor channel

L.L. was born as the product of a gang rape perpetrated on her mentally handicapped mother living in a foster home. She was brought up in the same foster home as a virtual slave, witnessing her mother being beaten and humiliated, the patient beaten if she tried to help her. Sexually abused throughout her upbringing by various foster family members, she left home in her mid-teens and supported herself since. She was stalked in her mid-20s, escaped to another city, but the stalker followed. When he threatened to harm her family unless she married him, the patient agreed. (This is the same homicidal husband she was eventually advised to leave.)

This story and associated affects came out after the therapist’s “slave role” intervention. Here, we can begin to map the developmental progression of the patient’s “slave basin” attractor onto her A-landscape, charting the channel of her self-negating experience from its source in her birth home to its tributaries in her marital, professional, and relational domains. Note that DST
formulation is not limited to the observational perspective but can flexibly incorporate both neuropsychiatric and subjectivity models. Such integrated formulation allows us to focus on multiple aspects of the patient’s self-experience ("It’s my fault"—ergo: mastery over helplessness), emotional awareness (anger diverted to self), her experience of others ("He cares enough to stalk me"—ergo: surrogate attachment), or subjective sense of meaning (martyr role—ergo: "I am worthwhile"). It can also help to reinternalize the patient’s sense of agency, such as the fact that others cannot "cause" her feelings: it is the patient’s job to direct her feelings where they belong and choose how she is going to act on them.

Step III: IDENTIFYING BIFURCATION POINTS

The patient is the only common denominator: not "what happened to her" but why she is choosing to maintain her dysfunctional patterns today (explicitly or implicitly).

In contrast to inanimate systems and organisms without reflective consciousness networks, human A-landscape is defined by a multitude of conscious and unconscious choices that we make in our lives. Events do happen to us beyond our control, but we endow them with meaning and ultimately choose how we respond to them. These choices underscore the fact that our perception and psychological reality are in part our active constructions (Tani, 1999), and constructions can be remodeled to achieve more adaptive interaction with our environment. Consider:

- What are the key choices (conscious or unconscious) that led to the patient’s current impasse?
- What predisposed the patient to react in those ways (connection to the core dysfunctional attractor system)?
- What meaning does the patient attribute to her choices?
- Why did the patient choose to come for help now (clinical syndrome not only as a problem but motivation to change)?

From the DST perspective, the importance of the patient’s choices (intentional stance) cannot be overemphasized: one’s agency is the only common denominator in her experiences, and it is her choices that differentiate blind reenactment of dysfunctional attractor templates from therapy-facilitated change (in philosophy of mind, this is the difference between "blinking" and "winking"). These choices are not always conscious, nor are the reasons for them always consciously available. Nevertheless, tapping into the power of changing one’s A-landscape is conditional upon owning the choices that have led to the present impasse, rather than picturing oneself as the victim of circumstances or blaming one’s actions on others.

Awareness of the patient’s choices in her previous therapeutic interactions can also inform the success or failure of the proposed treatment plan. Consider the following case vignette:

Case Vignette II:

D.M., a 49-y/o male engineer is referred by his psychiatrist for psychotherapy assessment. Present with unstable relational history, presently locked in a dysfunctional marriage. Multiple previous attempts at therapy (over 10)—all terminated by the patient within several months without prior discussion with the therapists. Eager to start combined individual/group therapy treatment (this is his second assessment session).
Therapist: "What are you going to do when you feel frustrated with your therapy here?"
Patient: "Why should I?"
Therapist: "Well, it happened with all the previous therapists you saw."
Patient: "Yes, but you are not them."
Therapist: "Granted, but you are still you."

[D.M responds with surprise, then frustration; discussion follows]

D.M’s pathological repellor ridge of sabotaging intimacy is clearly evident in his history and discussion of previous therapeutic attempts. Left to his own devices, there is an overwhelming probability that he would reenact a similar self-sabotaging cycle in his new treatment. In order to have a chance at succeeding, the patient would have to stay in therapy long enough to explore this repellor landscape and underlying templates associated with it, but in order to keep him in therapy, an intentional choice to address the cycle is required.

Recall that bifurcations occur in far-from-equilibrium conditions, where the systems cannot revert to its rigid linearity. In other words, the patient’s system has to be destabilized so it can reassemble in a new, more adaptive configuration (an everyday analogy is a pinball game, which has to be shaken gently for the metal balls to fall into new positions). The patient’s distress about his current situation, which frequently precipitates a therapy referral, is one destabilizing factor that may motivate change. However, this has not been sufficient in D.M’s multiple previous therapeutic engagements.

DST model would dictate that D.M’s linear transference mode has to be destabilized for his next therapy to have a chance at succeeding. In order to accomplish this, a firm confrontation would be required, which is generally a risky intervention during a second meeting, before adequate therapeutic alliance is formed. However, in the therapist’s judgment, such destabilizing intervention was critical at that point in order to facilitate the intentional stance. Indeed, D.M has now been in combined individual/group treatment for over 2 years, and has experienced several qualitative shifts in his relational cycle.

CONCLUSIONS

DST model allows us to shift the focus of psychodynamic assessment from collecting disparate sets of “objective” and “subjective” data—to systematically categorizing the patient’s experience from both perspectives simultaneously. Both biological and relational data can be examined in the language of complexity theory because mind/brain is a complex dynamical system accessible from objective (external), subjective (internal), and intersubjective (relational) perspectives. To make a musical analogy, we can either study sheets of music or listen to the piece being performed: each performer is unique, and each is going to evoke a different response in the listener. Patients present their “relational melody” to us, and we process it through the lens of our own experience. Analyzing the notes may be helpful—but the experience of attending to the performance is not reducible to the sequence of the notes on the sheet.

In addition, as therapists, we are not just passive listeners but active participants in the patient’s experience: the same “relational melody” is going to be expressed and interpreted differently in different therapeutic contexts. By immersing ourselves into the patient’s A-landscape, we bring our own inner landscape to bear upon it, and the resultant interaction of two complex dynamical systems is unique to each patient–therapist dyad, like a unique pattern of magnetic fields between

[Continue with subsequent text]
different magnets. As Amini et al. (1996) succinctly put it, “The therapist’s job is to allow the duet to begin and to take up his/her place in the melody, so that the piece can gradually be directed to a different ending” (p. 234).

The language of complexity theory offers a new trans-theoretical perspective that transcends the boundaries of traditional therapeutic modalities: it can help us integrate diverse therapy approaches and negotiate the psychodynamics/neurobiology divide itself. We can choose to label the attractor systems as synaptic network configurations, internal working models, core beliefs, object relational templates, implicit memory traces, or repetition-compulsion scenarios.

DST-informed formulation allows us to chart a unique map of each patient’s life experience, guiding individualized interventions that answer the patient’s specific needs. It can be of tremendous help in psychotherapy supervision, allowing trainees to approach their patients as unique individuals, lost and in need of guidance in their particular implicit terrain, rather than objectify them with diagnostic labels, theory-based interpretations, or manualized techniques.

Conceptually, the proposed DST approach can inform therapeutic process in important ways. It sets information as the common foundation for both brain processes and subjective experience, thus bridging the Cartesian gap, transcending the limits of deterministic linear science, and establishing free will and meaning firmly within the domain of the natural law. DST argues for a dual aspect approach to conceptualizing individual experience, with experiential learning and adaptation driving both synaptic network formation and patterns of individual perception, thought, and feeling. The patient’s choices, both explicit and implicit, assume a central part in the therapy process, the adaptive attractor landscape shaping the patient’s information processing. One function of therapeutic interventions becomes to shift the patient’s system away from its rigid equilibrium or chaotic attractors, thus allowing for new bifurcations to create a more functional attractor landscape and for the self-organizing process to reestablish itself.

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ADDENDUM

Integrated Dynamical Systems Therapy Formulation Template (aim for less than 1,000 words)

Part I: SUMMARIZING STATEMENT (ATTRACTOR TYPE)
  • Problems leading to this assessment – window into the patient’s present life
  • Problems the formulation will attempt to address – what are the postulated dysfunctional attractor systems

Part II: EPIGENETIC ANALYSIS: NURTURE-ON-NATURE (ATTRACTOR SHAPE)
  • Nature factors: biological vulnerabilities, temperamental characteristics, family history
  • Nurture factors: early dyadic interactions, family functioning, extended relational experiences, developmental trauma/neglect, cultural considerations
  • Dialectical synthesis: mapping A-landscape (how did the patient end up where (s)he is?)

Part III: CORE PATTERN RE-ENACTMENT (BIFURCATION POINTS)
  • Core dysfunctional attractor/template – its origin and manifestations (relate to presenting problems)
  • Patient’s choices that serve to perpetuate the cycle (bifurcation points: what does the patient contribute to the impasse?)
  • What meaning does the patient attribute to her choices (“Why do I do what I do?”)
  • Key strengths and weaknesses: insight, ego-strength, motivation, quality of object relatedness, defensive organization

Part IV: TREATMENT PLAN AND PREDICTED RESPONSE
  • Proposed ways of modifying A-landscape (what treatment the patient needs?)
    • Psychotherapy – what kind?
    • Psychopharmacology – what kind?
    • Behavior modification/support – what areas?
    • What is the patient willing to change at this time?
    • Anticipated problems in treatment: how is the known attractor pattern expected to affect here-and-now therapeutic interactions?