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Dynamic Process Methodology in the Social and Developmental Sciences

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Contents

Chapter 1
The Unbearable Dynamicity of Psychological Processes: Highlights of the Psychodynamic Theories

Rosapia Lauro-Grotto, Sergio Salvatore, Alessandro Gennaro and Omar Gelo

The term *dynamic* generally refers to the psychology grounded on and informed by psychoanalysis—even if dynamic perspectives do not necessarily coincide with it. It is well known that in Freudian theory, the dynamic level of analysis is that focused on conflicts and their role in shaping psychological facts. Yet contemporary psychoanalytically oriented psychology gives a broader meaning to the label, and consequently *dynamic psychology* is the psychology concerning the affective source (motivation, instinct, intra-psychic, and/or interpersonal conflicts) shaping (inter)subjectivity. Thus, in contemporary psychology the term *psychodynamic* can be seen as a synecdoche where the whole—the psychoanalytically oriented psychology—is referred to by means of the part—the dynamic level of analysis as conceptualized by Freud. Here we assume this broad definition. Therefore, henceforth the term psychodynamic will be used as being synonymous with psychoanalytically oriented psychological theory.

What Do We Mean by *Dynamic*?

As a starting point we will try to specify the semantics of the core concept of our discussion: *dynamic*. As matter of fact, the use of this term is characterized by a rather high level of polysemy. It is not within the scope of this work to achieve a systematic semantic analysis. In a stricter sense, we want to clarify the way we will use this concept in the discussion that follows.

We find it useful to distinguish between three general ways of using the term. As a premise, one can note that the attribute *dynamic* is often used in a metaphorical way, in order to connote certain phenomena—an object, a person, an event—as something active that is able to move (in space as well as in time) as well as to

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transfer its motion onto another object. Yet, because we are interested here in the concept as a scientific tool, as one enabling researchers to deepen their understanding of psychological phenomena, we will focus on two other levels: *dynamic* as a theoretical concept and as a methodological tool.

Dynamic as a Theoretical Concept and a Methodological Tool

First of all, the term *dynamic* can be used with a specific theoretical denotation. According to this use, a phenomenon is to be conceived as *dynamic* insofar as its manifestations show a set of defining features.[1] In our opinion, the defining characteristic at stake is the *explicit dependence on time*. In other words, qualifying a phenomenon as *dynamic* means that its temporal dimension can not be excluded by any sensitive description of the phenomenon. Any description that does not take into account the temporal evolution of the phenomenon would not show any power of explanation.

It is worth noticing that generally speaking, every phenomenon has some form of temporality. As matter of fact, a phenomenon is such precisely because it is a pattern of variability and this pattern cannot but have a space-time extension (Valsiner, 2007). From this perspective, one can refer to Kant and recognize that time is a fundamental way of shaping experience, and thus the perception itself of the phenomena. Yet a distinction is required here. One has to distinguish between the phenomenon—which necessarily unfolds through time—and the model of it, that can either take (or not take) time into account as a necessary descriptive/explicative dimension. According to this distinction, dynamic models are opposed to structuralist ones, depicting the phenomena in terms of a-temporal relationships between the elements of the observed system (Sève, 1972).

One can find many examples of structuralist models. For instance, Ignacio Matte Blanco's bi-logic theory (Matte Blanco, 1975) depicts the unconscious in terms of logical rules (principle of symmetry and generalization) according to which it generates forms of emotional categorization of the experiences. According to this theory, one can explain the unconscious process of meaning making just by referring to these rules, therefore without taking time into account.

[1] If one assumes, as we do, a non realistic epistemology, it would be more coherent to say that from a theoretical point of view a phenomenon can be denoted as "dynamic" insofar as its manifestations are suited to being depicted accordingly to a model of functioning of such phenomenon having some given defining characteristics. An assertion like this reflects the general epistemological a-ontological assumption according to which any theoretical attribute should not be considered as a description of an intrinsic, essential property of the phenomenon, but rather as an observer's category usable as a semiotic device in order to encounter the observed (Maturana & Varela, 1980). However, having made this specification here, in order to avoid to weighing down the exposition, we will take it as being valid for the following pages.

Psychodynamic Theory is Not a Synonym of the Dynamic Approach

According to the meaning entailed in its definition, psychodynamics should be particularly oriented to mapping the psychological process in a dynamic way. Yet this is only partially true. Psychopathology models, basic theories of the mind's functioning (what psychoanalysts call "metapsychology", inter alia, Rapaport, 1960) as well as the conceptualization concerning clinical methodology (what psychoanalysts call "theory of the technique", inter alia Odgen, 2004), all these sub-domains of psychodynamics tend to entail a vision of the psychological phenomena as a "moving" process, that is unfolding through time and pushed or shaped by needs, goals to be reached, and conditions to be overcome. Just to give one example, inter-subjective psychoanalysts (inter alia, Storolow, Atwood, & Brandchaft, 1994) highlight how people engage in co-construing the meaning of the interpersonal experience, using the patterns of affective meaning available for this purpose. By doing so people either succeed in developing new dialogical frames or they do not. The latter outcome grounds the psychopathological condition. In the former case a new interpersonal world is developed as the basis for further dialogical developments.[2]

However, if we shift the focus from the theoretical plane to the methodological one, we must conclude that on this latter level the various psychoanalytic perspectives share a general inability to carry out empirical analyses informed by a dynamic conception of the phenomena under scrutiny. Thus, if we look around for pertinent empirical studies, one can find laboratory and/or field experiments (for a critical review of the experimental approach in clinical research, see Westen, 1998), and applications of the methods of differential psychology (as can be found in psychopathological studies. For a review, Gabbard (2005), or in the literature on Attachment Theory, e.g., for a review, Cassidy and Shaver (1999). Of course, the historical-hermeneutic perspective has a very important tradition in psychoanalysis. One can specifically encounter single case analyses (starting from the seminal Freudian single cases). Yet these kinds of studies are characterized by a literal and metaphorical mode of description (Orsucci, 2006) that makes it hard to produce the kind of knowledge that is systematically and consensually usable outside the cases described, as well as outside the often implicit theoretical assumptions of the person giving the account.

The above considerations make it clear why we have chosen to adopt the term *psychodynamic*, instead of dynamic psychology: Psychodynamic is not (necessarily) a 'dynamic' psychology! Actually the issue is more complex. As we have recalled, psychodynamic theories model a huge spectrum of psycho-

[2] Obviously, not every psychodynamic theorist shares such a (broadly speaking) developmental look. Psychoanalysis is far from being an unitary domain: As Wallerstein (1998) states, there are many psychoanalyses, not one. Therefore, it should not be surprising to recognize that to some extent a mechanistic point of view is still represented in the psychoanalytic field. It would not be hard to give an example of a psychodynamic theory that sees the phenomenon investigated as an epiphenomenon of an underlying a temporal mechanism.

logical processes—and, we add, psychosocial too—in ways that highlight their dynamic nature. Nevertheless, psychodynamics has not systematically and consensually elaborated a methodology of empirical investigation coherent with the dynamic nature of the processes of interest. In this chapter we intend to highlight the dynamic nature of various psychological phenomena by referring to the psychodynamic theory. In the connected chapter (Salvatore, Lauro-Grotto, Gennaro, & Gelo, 2009) we discuss some of the main methodological issues concerning the empirical investigation of psychological phenomena once they are conceptualized as intrinsically dynamic.

While using the notion of *dynamic* as a methodological tool, one can refer to the repertoire of formal models and corresponding techniques of investigation that have the Dynamic Systems theory (DS) as their source. It is important to distinguish between the two meanings. This is because thinking of a psychological phenomenon as dynamic does not necessarily entail using DS. Yet, on the contrary, the adoption of such a methodological frame first requires that the phenomenon is theoretically defined as dynamic.

Dynamic Systems

In very general terms, a dynamic system is a mathematical model of a phenomenon: the phenomenon is a response to an external input that is dependent both on the input itself and on the inner state of the system. In fact at any instant t a dynamic system is described by the vector of a certain number n of time depending *on* state variables: $x(t) = (x_1(t), x_2(t), \ldots, x_n(t))$. If time is a continuous variable then the law that explicitly determines the evolution of the system takes the form of a system of differential equations:

$$dx(t)/dt = f(x(t), x_0, u(t), t)$$

$$y(t) = h(x(t), x_0, u(t), t)$$

where $x(t)$ is the vector of the state variables, $dx(t)/dt$ is its first derivative with respect to time, x_0 provides its initial conditions, while vectors $u(t)$ and $y(t)$ are the input and output of the system, respectively. The first equation expresses the variation of the state variables as a function f of the state of the system at time t, of the input and of the initial conditions. The second equation describes the functional law h for the evolution of the output, that is the response of the system, from which the internal state has to be read out.

From the mathematical point of view, the description of a dynamic system implies the integration of the system of equations which allows for the computation of the function describing the temporal evolution of the state variables $x(t)$, the so called *transition function*. This function, once assigned to the state of the system at an initial moment t_0, allows the state of the system at any subsequent instant of time to be determined. Therefore, in connection to our previous discussion, the mathematical function is the formal law of the development of the phenomenon.[3] It is worth pointing out that the DS is not a unitary repertoire of models. Rather, it is a family of formal methods, each of them focusing on a kind of system or of conditions of systemic functioning. In accordance with the aim of our discussion, we concentrate on the models that are more useful for psychological investigation.

A Basic Typology of Dynamic Models

Two fundamental features allow a useful classification of dynamic systems. First, systems are said to be *stationary* or *time invariant* if the equation's parameters are constant in time, and *non stationary* otherwise. A second crucial distinction we have to take into account is the one between *linear* and *non linear* dynamic systems. In the case of linear dynamic systems, even if the state of the variables depends on time, this dependence is stable. This characteristic is reflected on the formal level, in the fact that the temporal evolution function describing the state of the system is defined by of first order equation(s).[4] As a consequence, the linear dynamic system preserves the property of compositionality, or in converse terms, of the linear decomposition of variables, and the tools of matricial algebraic calculus can be applied. Non-linear systems are on the other hand described by equations of order higher than one (see Note 5). For this reason, in this case linear compositionality of the solutions is not given (Strogatz, 1994; Kaplan & Glass, 1995).

The simplest example of a linear dynamic system is given by the map (i.e., an equation for discrete time steps) representing the evolution of the density of a population evolving in an environment with unlimited food resources.

$$X(t+1) = rX(t)$$

where *r* parameter expresses in a suitable way the dependence on the death rate and the reproduction rate. The evolution of the system is given by the law expressing the behaviour of the population density for $t \to \infty$ (asymptotic behaviour). It

[3] DS specify the properties of the transition function of a dynamic system. Here we will try to rephrase the properties in a less formal way. *Consistency* implies the existence of a well defined state of the system at all time values and for all admitted input functions; *compositionality* implies that evolution in time can be described 'step by step', taking the state reached at a given time point as starting condition for subsequent computations; *causality,* implies that if two dynamic systems with identical transition function but starting their evolution from two different initial conditions and different inputs, are found to be in the same state at a given time point, and if they receive the same input thereafter, they will have the same evolution in time, irrespective of the differences due to the initial conditions and previous evolution.

[4] In general terms a first order dependence is expressed in the form of a polynomial having variables with low power = 1, i.e., $y = ax + b$. The typical feature of a linear dependence is that the correspondence between a given increment of the independent variable, Δx, and the corresponding increment of the dependent variable, Δy, is given by a constant, and therefore is not dependent on *x*.

depends on the value of parameter r. For $r = 1$ the population density keeps constant $(X(t+1) = X(t))$ in time; for $r > 1$ it has an exponential growth to infinity and for $r < 1$ the population density has an exponential decrement towards 0.

In order to avoid confusion it is important to note that although the equation governing the evolution of the system is linear in the sense that $X(t + 1)$ is linearly dependent on $X(t)$, this does not imply that the dependence of X on time t should be linear as well. On the contrary it can be shown that exponential growth or decrement of the dynamic variable $X(t)$ on time[5] are the solutions of this linear equation. This is the known case of the exponential growth of the population in a bacterial colony in which all the bacteria split themselves in two at, say, every 20 min.

Periodicity

According to our aim an interesting type of linear dynamic system is the one that shows a periodic behaviour. As an example, consider the harmonic oscillator,[6] corresponding to a point of mass m executing small oscillations due to a spring of elastic constant k in the absence of friction. This system has two independent solutions, describing the sinusoidal oscillation of the point around the rest position. Due to the property of *compositionality*, typical of linear systems, any linear combination of the two independent solutions will be a solution of the equation as well.

A convenient way of depicting the behaviour of a system in time is by representing its evolution by a trajectory in the phase space. This is a ‘shaped’ space—a variety in mathematical terms—(it can be a plane, a cylinder, a torus, and so on…) having the degrees of freedom of the system as dimensions: the points of the phase space are all and only the possible states of the system. The time evolution of periodic systems can be represented by a closed orbit, with every point representing the position of the system in the phase space at a given instant. The perpetual motion of a pendulum (in an empty space) is the typical example of this kind of trajectory. The interest of the periodic trajectory is that it allows the depiction of a behaviour that appears to be changing in time—i.e., the velocity of the mass point of the oscillator changes instant by instant, increasing and than decreasing, and so on—yet is globally stable, in the sense that the system tends to come back to the same point of (unstable) equilibrium. As we will show in detail below, this kind of cyclic trajectory is consistent with various psychodynamic conceptualizations.

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[5] The typical feature of a non-linear dependence on time is that the correspondence between a given increment of the independent variable, ΔX, and the corresponding increment of the dependent variable, Δt, is not constant. In our example, consider the case of an exponential growth of the density of a bacterial colony in vitro, described by the transition function $X(t) = X_0 \exp(t)$. In this case the population density roughly triples at each time step, with a ΔX that becomes larger and larger as time elapses.

[6] This is indeed a second order linear system as it is the second derivative of the displacement from the rest position $d^2x(t)/dt^2$ that is linearly dependent on $x(t)$, as the equation reads: $d^2x(t)/dt^2 = -(k/m)\,x(t)$.

Deterministic Chaos

Deterministic chaos is another important branch of DS, in this case concerning non linear systems. Chaos characterizes the behaviour of non linear systems for specific values of the parameters in the set of equations defining the system. Consider as an example the map (i.e., an equation for discrete time steps) describing the temporal evolution of the population density $X(t)$ in a given environment characterized by given values of the death rate, reproduction rate, and starving rate.

$$X(t+1) = R\,X(t+1)\big(1 - X(t)\big)$$

Here R is the only parameter expressing the dependence on the death rate, reproduction rate and starving rate, which determines the qualitative nature of the behaviour of the system. In fact for $R < 1$ the death rate dominates the behaviour of the system, which evolves towards extinction from all the possible starting values of X ($X = 0$ is therefore the 'fixed point' toward which the system does spontaneously evolve). For $1 < R < 3.45$ a stable fixed point with $X \neq 0$ emerges and the fixed point $X = 0$ becomes unstable. For $R \geq 3.45$ the system undergoes a *bifurcation*, that is, instead of a single fixed point it expresses two different fixed points for the dynamics, with a cyclic fluctuation of the population density. As R further increases more and more bifurcations take place, and for $R \geq 4$ the system enters the chaotic regime. This is a classical way in which a transition from a non chaotic to a chaotic regime can take place and it is known as the *bifurcation route to chaos*. It is important to note that the manipulation shifting the system from a periodic to a chaotic regime is the fine tuning of the *parameter* of the equation: R is therefore the *control parameter* of the system.

In general terms, chaos is an erratic, (apparently) random behaviour yet it is the effect of a definite—deterministic—rule. There are two fundamental properties defining a system as chaotic. Firstly, the *sensitiveness to the initial conditions*—a principle better known as the *butterfly effect*. Let us imagine a system starting with a given initial condition, say condition α. Let us now imagine introducing a slight modification (ε) to this condition, transforming it to β. A non chaotic system keeps the slight modification constant for a long time, so that also after an arbitrarily long period of time the difference between the trajectory starting in α and the trajectory starting in β remain more or less ε. This does not happen in a chaotic system. In this case, even if the initial modification ε is slight, yet the two trajectories (the initial and the modified) can dramatically diverge.

In sum, a small change in the initial condition creates impressive consequences over time, like the motion of the butterfly's wings in Cape Town that—after a while—can produce a tornado in New York. Getting back to the previous example, two different populations starting their evolution in time with very similar initial densities in the same environment could end up with a totally different final destiny if the environment parameters amount to an $R \geq 4$!

It is worth noticing that this property is responsible for the intrinsic unpredictability of the system over a long enough period, because even slight differences in the measurement of the initial condition—and no measure can be absolutely precise—lead to truly huge variation of the trajectories. A second property of chaotic systems is the *density of the periodic orbit*. The trajectory of a chaotic system keeps itself within a circumscribed portion of the phase space (strange attractor). This means that the system does not assume all the possible infinite values represented by the infinite points of the phase space; rather it reduces its variability through time—for this reason, the chaotic behaviour is a case of dissipative system. Nevertheless, the chaotic system is not periodic: however wide the range of time assumed, the system will not present the same state twice. In geometrical terms, the system will never pass twice through the same point of the phase space. This means that however small is the sub-region of the phase space in which the orbit of the chaotic system is confined, one will find infinite points, each of them representing the state of the system in a generic instant *t*. The presence of strange attractors leads to the recognition that even if the chaotic behaviour seems random, actually it is the expression of a different, more complicated order. A chaotic trajectory shows a *quasi-periodic* course: it reproduces similar cyclic behaviour over the time, yet always different to a certain extent.

Self-Organization

The last type of dynamic system is the kind that maps processes of self-organization. Like the chaotic system, this kind of model concerns complex order as carried out by a non linear system. Yet, differently from the chaotic system, a self-organized system is characterized by a huge amount of microelements—i.e., the neurons of a neural network of the Hopfield type, (Hopfield, 1986)—that can function either in a deterministic (noiseless case) or in a stochastic (noisy case) way. This kind of system is usually defined by assigning the transition function for each microelement (i.e., the updating rule determining for example that a neuron will fire when the weighted sum of the signals it receives from its neighbors passes a given activation threshold) on the basis of a theoretical description informed by the modeling of a physical or a biological system.

A crucial feature is that the microelements are constantly interacting with each other, and the law expressing the strength of the interaction is probabilistic in nature (Amit, 1989). These kinds of models focus on the description of the modality and the condition under which an emergence of order is achieved through—and by means of—the interaction of the micro-elements. For example in the Hopfield model (Hopfield, 1986) a network of many stochastic neurons exhibits stable states that are highly correlated with a set of patterns stored in memory. It is therefore possible to employ the model in order to simulate a content addressable associative memory. In this system a given pattern of memory (take for example, the representation that is formed once you are introduced to a colleague in an international meeting) is stored by enhancing the synaptic connections between the neurons that are activated during the first exposition to the stimulus. Once the system is presented with a corrupted or in some way altered version of the stimulus (i.e., you meet your colleague again a few years later, in a different context and he looks older), the network dynamics is able to retrieve the original stored pattern, thus allowing the experience of recognition (maybe in the form of a kind of 'AH-HA!' experience). This type of memory system is said to be a content addressable memory because the cue that is needed in retrieval is a part of the content of the memory itself, in contrast with A.I. systems in which the actual location where the information is stored has to be specified in order to recall the information.

As an example of application consider the model described by Lauro-Grotto, Reich, and Virasoro (1997). In this model several networks of the Hopfield type are connected in order to simulate a multimodular semantic network. Each module represents a set of possible connotations of a given concept, i.e., its sensorial appearance (visual module, tactile module…), the way in which it can be employed (functional module), the name that designates it in its written and spoken form (verbal module) and so on. The constraint of the dynamics of the multimodular network can be explored both analytically and by simulations, and predictions can be made on the behavior of the system in the presence of neural damage. The behavior of the damaged model appears to be highly reminiscent of the behavior of patients suffering from semantic dementia, a neuropsychological deficit characterized by neural loss in the mediotemporal lobes.

Another example of this modelistic approach is the synergetic theory (Haken, 1992). Synergetics focuses on systems constituted by a very high number of microscopic components functioning in a stochastic way—i.e., the molecules of a fluid. Under specific conditions—depicted in terms of given values on one or more control parameter(s)—the behaviour of the micro-components starts to follow a common rule: an *order parameter* emerges in the dynamics of the system. This is a global variable that sensitively describes the dynamic behaviour of the system. For example in the case of the Hopfield network the order parameters are global variables that estimate the overlap or superimposition of network states and memorized patterns (the overlap being equal to 1 when the network state is perfectly reproducing one of the memorized patterns). All states corresponding to the retrieval of a given memory are characterized by the fact that they have a single overlap close to 1 while the others stay close to zero. At equilibrium the single neurons in the network can show fluctuations in their activation states, yet the fluctuations appear to be balanced across the system, so that the neurons altogether do co-operate in keeping the overlap values stable. According to the terminology of the theory, in cases of this kind, the micro-components enslave themselves to the order parameter. In so doing, a coherent pattern emerges as a global property characterizing the system as a whole. A typical example of a dynamic system exhibiting an order parameter in the physical domain is the laser: below given values of the control parameter, the photons stop their stochastic behaviour and enslave themselves to a common rule that transform them into a single mechanism with specific properties of order.

The crucial property of these types of dynamic systems is *universality*: the emergent behaviour appears to be independent from the actual form of the dynamics of the interacting elements provided that (1) the non linearity of the dynamics is taken for granted and (2) a sufficiently large amount of elements are put in interaction

(Mezard, Parisi, & Virasoro, 1987) This implies, for example, that the collective behaviour of a neural network of this type will be more or less the same if the neuron activation dynamics is changed from a sigmoid to a step function (both are non linear functions), provided that a large amount of neurons are placed in interaction. "'More' is different!" intones the theoretical physicist P. Anderson in the famous manifesto about Complex Systems (Anderson, 1972).

The Dynamic Nature of Psychological Phenomena

Let us look at typical phenomena of the psychodynamic domain, whose modalities of working make it clear that there is the need to develop more sophisticated models of investigation than the traditional ones that entails a linear and stationary idea of the psychological phenomena.

Periodicity

First of all, psychodynamics highlights various examples of processes showing an intrinsically periodic trend. Maybe the best known of these examples is given by the bipolar disorder. This psychopathological syndrome is indeed characterized by the alternation of a phase of depressive and a phase of the maniacal state (DSM IV-R). These two conditions are dramatically opposed to each other, and in many cases are presented according to a regular cyclic period, regardless of the environmental variability. The evidence of such regularity is one of the main issues leading the majority of the clinic researchers to give a relevant rule to neurobiological determinants, even if no conclusive evidence has been provided in order to understand the exact role played by the neurotransmitter system. One may or may not agree with the strong biological point of view, yet the systematicity of the cyclic way the syndrome appears is a fact that cannot but lead us to consider periodicity as a constitutive characteristic of the phenomenon in question.

However, it emerges that cyclicity plays a role in other psychological diseases. For instance, various authors highlight how a subgroup of subjects affected by narcissistic personality disorder is characterized by the alternation of moments of grandiousness and high self-esteem and moments of low self-esteem, feeling of incompetence and fragility (Dimaggio & Semerari, 2004).

Periodicity in Psychotherapy

Another domain in which periodicity seems to play a critical role is that of the processes shaping the psychotherapeutic field. Let us consider the discussion on the role played by the therapeutic alliance in psychotherapy. This concept was introduced at the end of the 1970s in order to distinguish between transference reaction and competent participation of the patient in the clinical process (Bordin, 1979). There are different specific definitions of this concept; yet more or less all of them concern three issues:

- the quality of the interpersonal bond between patient and therapist;
- the patient agreement on the goal of the treatment;
- the patient commitment to the work entailed in the treatment.

An increasing number of studies have been using this concept since its introduction (Lambert & Barley, 2001; Martin, Garske, & David, 2000). The therapeutic alliance has thus acquired the status of the most widely recognized dimension of clinical effectiveness.

However, it is interesting to observe a shift in this literature. Initially, authors assumed a linear linkage between therapeutic alliance and clinical quality and/or effectiveness of the psychotherapy: the more intense the work alliance, the greater the effectiveness. In the last ten years this assumption has been brought into question, in favour of a vision that sees the therapeutic alliance as having a cyclic trend which alternates between the positive and negative poles. Thanks to the seminal contribution of Safran and Muran (2000) it has become clear that what is clinically significant is not the absolute trend of the alliance, but the capacity of the therapeutic dyad to systematically cooperate in order to repair the inevitably micro-ruptures of their bond. This means that the clinical process unfolds in terms of a cyclic process of ruptures and repairing, of reciprocal closeness and separation.

Moreover, both psychoanalytically and cognitively oriented authors have argued in favour of the cyclic trend of a clinically effective treatment. The psychoanalyst Bucci (1998) models the psychotherapy process according to the concept of Referential Activity that she elaborated within a comprehensive theory of the relationship between conscious and unconscious thought. Referential Activity is the function of the mind that, within the symbolic domain, grasps components of pre-symbolic thought. In other words, the referential function enables the subject to mentalize the emotions, by bringing them into language. And it is indeed in language that one can see the referential function in action: Bucci's method of psychotherapy process analysis focuses on the incidence, within the therapist and patient's discourse, of affectively charged words. The method is based on a software with various vocabularies, each of them measuring an aspect of the affective charge of a rich list of words—using the dimensions of concreteness vs abstractness, specificity vs generality; capacity or incapacity of emotional resonance—Bucci (1998) has shown that clinically significant sessions of the psychotherapy process present a cyclic pattern with phases of high referential activity alternating with phases characterized by low referential activity. This pattern is consistent with the author's psychoanalytically informed theory assuming the mind as working in terms of phases of retrieval of affects experienced and phases in which the mind elaborates them in terms of reflective thought.

A similar look at the psychotherapy process—entailing a more general vision of the mind's functioning as well, is provided by the Therapeutic Cycle Method of

Mergenthaler (1996, 1998) (TCM). TCM is a method aimed at identifying clinically relevant moments in the psychotherapeutic process through the analysis of emotional-cognitive regulation. TCM assumes that psychotherapeutic change is produced when the patient is adequately able to regulate and reflect on affective experience (for related concepts, see Horowitz, Kernberg, & Weinshel, 1993). TCM works by means of a software for statistical content analysis (CM software), that calculates the occurrences of two sets of words, identified as markers for emotional (EM) and abstract (AB) language respectively. The periodic non-random variation of the combinations of these parameters allows four emotion-abstraction patterns to be classified as:

a) *relaxing*, when both ET and AB are low (both are below the mean): Patients talk about material that is not manifestly connected to their central symptoms or issues;
b) *experiencing*, when ET is high (over the mean) and AB low: Patients find themselves in a state of emotional experiencing. Patients may be raising conflictual themes and experiencing them emotionally;
c) *reflecting*, when ET is low and AB high: Patients reflect and discuss topics with a high amount of abstraction and without intervening emotions. This may also be an expression of the defense known as intellectualization;
d) *connecting*, when both ET and AB are high: Patients have found emotional access to conflictive themes and they can reflect on them. This state marks a clinically important moment that often coincides with a moment of insight or possibly a moment of change.

These four emotion-abstraction patterns have been shown to allow for the identification of emotional-cognitive regulation, significantly related to the psychotherapeutic process (e.g., Fontao & Mergenthaler, 2007; Mergenthaler & Gelo, 2007). TCM considers *connecting* to be a marker of the ability to reflect upon emotional experience, that should therefore be understood—according to the theoretical approach one refers to—in terms of emotional insight (Fontao & Mergenthaler, 2007), meta-cognitive functioning (Semerari, Carcione, Dimaggio, Nicolò, & Procacci, 2007), or reflective functioning (Fonagy, Gergely, Jurist, & Target, 2002). Finally, TCM does not allow the four patterns to be interpreted independently from each other and in a linear way. Rather, a specific periodical temporal combination of these emotion-abstraction patterns is considered to identify one or more *therapeutic cycles*. A therapeutic cycle is conceived to detect clinically relevant moments of active therapeutic engagement Fig. 1.1 shows the ideal clinically relevant process. It begins with a *relaxing* phase, when the patient is not affected by the previous state of arousal and therefore is in the better condition to be engaged in the psychotherapeutic exchange. Then, the therapeutic context allows affective contents/state of the mind to be triggered and experienced by the patient (*experiencing*). Much of the therapeutic work is then directed at triggering and allowing a process of reflection upon the affective states experienced (*connecting*). If the patient is now able to activate his cognitive processes, it will be possible to create a meta-cognitive link between the affective states experienced and the cognitive understanding of them,

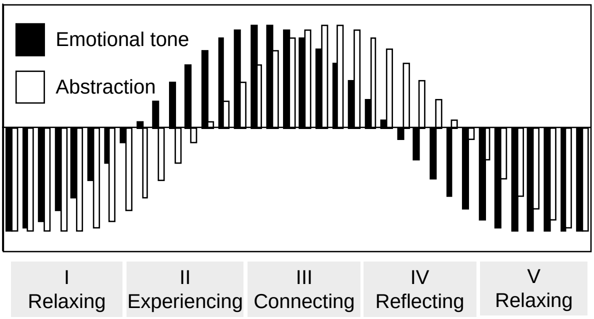

Fig. 1.1 The ideal clinically relevant process as modelled by TCM

in so doing "filling up" the cognitive understanding with a deeper reference to its emotional content. This is considered to be a necessary prerequisite for therapeutic change. Finally, the emotional component diminishes, and it is now possible to reflect and cognitively elaborate what happened up to that moment, eventually creating a distance from the previously experienced affective states (*reflecting*).

According to the method, cycles can be considered a process-base mediator of outcome, having proven to enable the identification of clinically significant moments within the therapeutic process related to psychotherapy change (Kraemer, Lihl, & Mergenthaler, 2007; Lepper & Mergenthaler, 2005, 2007).

Non-Linearity

A multiplicity of convergent perspectives leads to thinking that non linearity is the rule rather than the exception in psychodynamic matters. First of all, clinical processes often do not appear to be following continuous and constant trends. Despite the fact that clinicians usually tend to consider and empirically investigate clinical change as a linear and incremental process, there are a lot of clinical and empirical evidences leading such a traditional conception to be questioned. In a recent work, Hayes, Laurenceau, Feldman, Strauss, and Cardaciotto (2007) list some of these issues. Various studies have documented that only in some cases does the life trajectory following very dramatic and traumatic events evolve coherently with the local effect of the trauma, that is in terms of the onset of pathological conditions (so called Post-traumatic Stress Disorders). In various cases people are shown to be able to regain their pre-trauma condition. In further cases the traumatic event is shown to be the premise and the means for reaching an even better psychological condition (the so called Post-Traumatic Growth). Other studies have shown that people with clinical problems—e.g. with problems of substance abuse—can carry out deep change in their condition, as result of a sudden, rapid and global transition. Moreover, this kind of change is often preceded by periods of worsening of the clinical condition. Other clinicians have highlighted how the clinical improvement can follow a threshold mechanism, as a consequence of the accumulation of a set of eliciting conditions, yet none of them enables one to be singularly effective. Finally, many studies on psychotherapy process-outcome show that the clinical improvement—often measured in terms of level of the symptomatology—does not spread homogeneously throughout the course of the clinical treatment. Rather, at least in good outcome cases, most of the outcome occurs in an early phase, with the following course presenting a lower rate of improvement (Lambert, 2004).

Second, in many cases the development of aspects having clinical relevance shows regular, but not linear, trends. Barkham, Stiles, and Shapiro (1993) have introduced the parameter of curvilinearity, concerning the rate of change in important clinical problems occurring during the course of psychotherapy. They did so in order to take into account what clinicians know very well: progress in psychotherapy is never constant; it may in fact show sudden accelerations or blocks. Authors have used a quadratic curve in order to model the curvilinearity, according to a hypothesis of a U-shaped clinical trend. Their findings clearly supported their hypothesis. However, they underline that other kinds of curves (cubic or of higher order) could also be used. Recently, some of us, working with other authors, have proposed and successfully tested a similar approach to the psychotherapy process (Salvatore, Gelo, Gennaro, Manzo, & Al-Radaideh, in press), called *Two Stage Semiotic Model* (TSSM). The TSSM asserts that good-outcome psychotherapy is characterized by a U-shaped trend of the super-ordinate meanings working as semiotic organizers of the discursive exchange between the patient and the therapist (cf. Fig. 1.2).

According to the TSSM, the psychotherapy process can be depicted as a two-phase course. In the first stage the patient-therapist exchange works fundamentally as an external source of limitation on the patient's system of assumptions, whereas in the second stage the patient-therapist dialogue works in support of the patient's activity of creating new meanings. Therefore, in the first stage, the therapeutic dialogue operates fundamentally in a de-constructive way, placing constraints on the regulative activity of the patient's expected super order meanings (Salvatore & Valsiner, 2006). In the second—constructive—stage, the patient-therapist dialogue

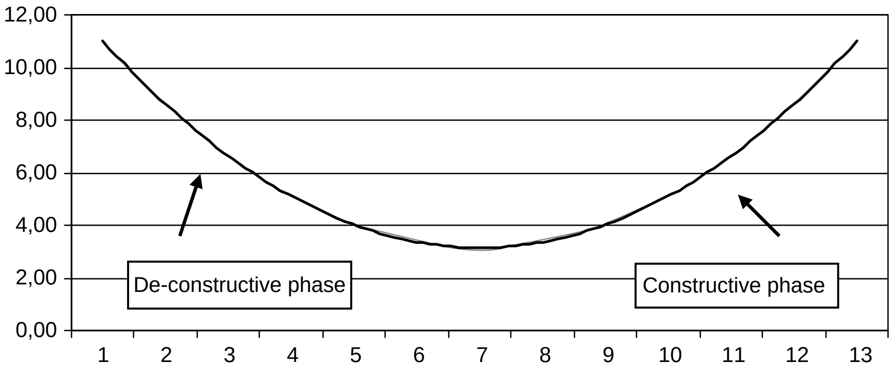

Fig. 1.2 U-shaped trend of super-ordinate meanings working as semiotic organizers of patient—therapist discursive exchange

implements new super order meanings, replacing the previous ones in regulating the meaning-making experience.

Obviously, the two stages are not totally distinct and mutually exclusive. Both of them can be active throughout the whole psychotherapy process, within every session, though to different extents. However, TSSM asserts that at the macro-analytical level, in a clinically efficacious process one can differentiate the psychotherapy process into a first phase where de-constructive meaning-making is dominant and a second one where the dynamic of meaning-making acquires a constructive function. What is worth noticing here is the fact that this kind of study allows us to underline that clinical development does not have a constant trend—one where the composition effect principle is valid. Yet this does not necessarily entail a lack of regularity; instead, it points to a more complex, non linear regularity, to be described with a function of an order higher than one (empirical evidence concerning the TSSM assumption is presented in Salvatore and colleagues, this volume).

Chaotic Order

Periodicity and non linearity are characteristics of the clinical phenomena that are very close to the experience of the researcher and professionals in the field. Moreover, the study of individual trajectories plays a central role in the cultural and methodological background of the clinical and psychodynamic disciplines. For this reason, it is easy to retrieve empirical investigations that—like the ones we referred to in the previous session—are consistent with such a standpoint. The task becomes harder in the case of deterministic chaos. As matter of fact, despite the interest shown by some researchers for this kind of dynamic processes,[7] very few empirical studies take into account and/or use chaos theory (Hayes et al., 2007).

Psychotherapy as a Chaotic Process

Schiepek and colleagues provided the only empirical investigation of the psychotherapy process based on chaos theory (Kowalik, Schiepek, Kumpf, Roberts, & Elbert, 1997; Schiepek, Kiwalik, Schutz, & Kohler, 1997). They submitted 13 sessions of a psychotherapy case to a multi-stage analysis. First, the authors coded the psychotherapy by means of a qualitative coding system (the Sequential Plan Analysis) aimed at identifying the interactional strategy of both the client and the therapist. According to this

[7] "Chaos theory's image of patterned complexity offers a far better picture theory (…) to guide our research efforts than does experimental design's billiard ball determinism image of direct and linear causality. An alternative to experimental studies in psychotherapy is a research approach which recognizes the complexity of the psychotherapeutic process and attempts to analyze the complex unfolding of moment by moment performance of people in specific states and contexts" (Greenberg, 1991, p. 8).

method, more than 3400 ten-second segments of a psychotherapy session were coded into seven super-ordinate categories that refer to the therapist's and the client-therapist strategy of interaction such as "trust/create secure atmosphere"; "confrontation/search for insecurities" (by the therapist) and "search for sympathy/appreciation/good relationship" and "problem oriented work" (by the client). Authors interpret such categories as general plans of "self-presentation … reflecting the strategic purposes and emotional schemata of the client or therapist" (Kowalik et al., 1997, p. 198).

For our purposes here, we need to examine the anatomy of the Kowalik et al. (1997) study. They had independent judges to attribute the intensity of each category to each of the 10 s units. As a result, seven parallel time series of data were obtained, representing the data base for the further analysis aimed at verifying the hypothesis of the chaotic behaviour of the psychotherapy process. As a starting point, the authors start with the assumption (cf. Schiepek et al., 1997) that the psychotherapy process can be modelled as a stationary (ergodic) non linear system—that is as a system whose dynamic state does not change through the time. On the basis of this assumption, they provide three different kinds of tests. Firstly they verify the deterministic nature of the time series, that is the possibility to interpret it as being different from noise. In order to do so, they apply a series of analyses based on the logic of the component analysis (Fourier transformation and Autocorrelation Function) as well as a measure informed by the topological analysis of the reconstructed phase space in which the time series are embedded (intuitively speaking, the phase space's axis is provided by specific temporal lags). They compare the output characterizing the time series with that produced by a noise trajectory and that produced by an already recognized chaotic system. The psychotherapy process shows a pattern similar to the latter and different from the former, and this leads the authors to conclude that the time series present the characteristic of a deterministic trend.

Secondly, in order to verify the presence of a chaotic attractor they measure its dimensionality, in search of a fractal dimensionality, which is a defining property of chaos. However, contrary to expectations, the results do not fit with the hypothesis of the presence of a strange attractor. The authors explain this unexpected result as a consequence of the low amount of data and/or of the high dimensionality of the time series, that is of the huge number of variables needed to explain their variability.

> The variability of the stationary measures estimated in this study can be seen as an indication of the non-stationary character of the interaction between client and therapist. In addition, we may question the methodological suitability of the stationary dimensionality measures for the application to behavioural data, i.e., coarsegrained and relatively short time series (including only some hundred or thousand data points). (Schiepek et al., 1997, p. 184).

Third, they calculate the Largest Lyapunov Exponent (LLE) specifically aimed at verifying the salience of the sensitive dependence on the initial conditions. The LLE measures the maximum divergence—through time—between the time series trajectory on the phase space and another given trajectory produced by a slight perturbation of the original trajectory. If the parameter surpasses a certain threshold, this is interpreted as the reflection of the fact that the slight perturbation has produced a wide differentiation in the temporal evolution of the system. Findings support the hypothesis of a sensitive dependence.

The authors underline that taking the results of the first study (Kowalik et al., 1997) as a whole, even if they highlight cues of deterministic chaos, nevertheless they lead one to think that the time series analyzed are not consistent with the initial ergodic/stationarity assumption. According to this consideration, they developed a second stage of analysis in a further study (Schiepek et al., 1997), which was based on nonstationary measures: entropy rates and an adjusted version of the dimensionality test and of the LEE (local LEE). The findings of this second study support the hypothesis that the psychotherapy process not only presents a chaotic dynamics, but also a dynamics showing critical transition within and between the sessions.

Interestingly, the authors emphasize that these transitions have to be viewed only in analogy with the mathematical concept of *phase transition*. As matter of fact, the latter entails a change of the control parameter of the system—which is an environmental condition, external to the psychotherapy process. Such condition is evidently not included in the study in the case of psychotherapy.

> The sudden chaoticity jumps we observed are not transitions in the sense of real "phase transitions," as this would require a change of at least one control parameter. In order to observe such changes, experimental manipulation of the control parameters would be necessary, which has not been realized.
> In general, the analogy between experimental and therapeutic process is applicable to a very limited extent, because the important sources for change during therapy arise from the client and the client-therapist relationship and not from outside.
> The therapist is part of the therapeutic system and not an externally controlling source of an independent variable. Theoretically it is not yet clear what might be a suitable control parameter for therapeutic phase transitions. A possible candidate might be the client's motivation for change, though this is not an environmental parameter like the energy input for the laser or the temperature gradient (…) but a parameter inherent in the process (Kowalik et al. 1997, p. 212).

This is a very significant point, highlighting a possible weakness in using chaos theory in the case of psychological phenomena (at least when depicted at the behavioural level).

Sensitive Dependence on the Initial Conditions

Apart from the above-mentioned study, we found no other example of empirical investigation of psychodynamic phenomena according to chaos theory. We therefore have to keep our discussion on a qualitative and analogical level, with the aim of offering some "hints of chaos" that could legitimate those who intend to bet on the validity (and heuristic utility) of modelling psychodynamic phenomena according to chaos theory.

Let us start with the principle of the *sensitive dependence on the initial conditions*. As already mentioned, this is a central characteristic of chaotic behaviour to the extent that among non specialists, chaotic behaviour often tends to be solely identified by this feature. The validity of this principle in the case of psychological phenomena is a critical issue. As a matter of fact, the sensitiveness seems to be the opposite of equifinality, which is a central quality of psychological development (Sato, 2009). A psychodynamically oriented clinician should actually be quite in agreement with the assertion that the processes of affective intersubjective sense-making show ways of functioning that can easily be described as forms of sensitiveness to the initial conditions.

More particularly, the psychoanalytic literature collects a huge repertoire of vignettes from psychotherapy (e.g., Hoffman, 1998) which, in one way or another, highlight how patient and therapist continuously co-construct the affective sense of their encounter and how this affective semiotic co-construction is strongly depending on and carried out by means of nuances: the tone of the voice, the variability of speech speed, slight movements of the body, the angle of the glance, as well as the words used, the content choice… One who has psychodynamic clinical experience has no difficulty understanding what many clinical sketches suggest, that is, that very trivial incidental and casual details—e.g., the circumstance of the therapist arriving a little late, the words he uses to welcome the patient …can have a very deep middle to long term impact on the course of the clinical process.

Empirical Traces of Sensitive Dependence on the Initial Condition

Venuleo, Salvatore, Mossi, Grassi, and Ruggeri (2008) analysed the discursive exchange occurring in high school teaching, between students and teacher. According to the point we would like to make here, this analysis shows how the affective intersubjective regulation of the participants' reciprocal positioning is carried out by means of subtle discursive devices (e.g., see the use of words like "guys", "want" "somebody" in a sentence like this: "Well, guys, now I want to examine somebody", as compared with a sentence like: "Well, students, we must have a test now"). This fine tuning is very hard to recognize in real time, but at the same very meaningful in creating the emotional sense of the social bond (Salvatore & Venuleo, 2009).

Salvatore, Quarta, and Ruggeri (in press) compare the effects of playing with violent videogames on the experience of aggressive feeling (measured by means of self reports in a sample of 14- to 18-year-old boys and girls). The subjects are distinguished according to two dimensions: the cultural value attributed to the videogames (a videogame eliciting a form of valorised violence—a policemen fighting against criminals in order to defend himself—versus an illicit form of violence—a criminal shooting people with intent to steal), and the situated social meaning of the activity of which playing is part (playing as a way of participating in an interpersonal frame—a competition—versus playing alone, as an individual activity). The results show that the effect of playing with a violent videogame is not invariant. Rather it varies according to the cultural and social meaning attributed to the playing. More particularly, the participants playing the illicit videogame alone show the lowest level of aggressive response. The participants playing the valorised videogame alone show the highest level of aggressiveness: the users playing interpersonally, whether it be the illicit or valorised videogame, present intermediate levels of aggressive response. As far as the present discussion is concerned, these results show how a difference in the background of the experience (and individual or interpersonal background) has a significant role in shaping the psychological effect of the experience itself. In the final analysis, this finding highlights how the semiotic meditational role played by the context of the experience can be conceptualized as one way sensitiveness to the initial condition manifests itself in the realm of psychological phenomena.

The Dissipative Trajectory

A psychodynamic approach to language focuses on the constructive role affects play in language (Salvatore & Venuleo, 2008). In agreement with various socio-constructivist points of view (e.g., Rommetveit, 1992; Valsiner, 2007) this approach underlines that the signs are intrinsically polysemic (Mossi & Salvatore, in press). According to Wittgenstein (1958), the reciprocal attunement among people involved in a communicational exchange cannot therefore be considered a natural given premise grounded on some kind of universal clearness and completeness of the language—but it should be seen as a by-product of the communicational exchange itself (Salvatore, Tebaldi, & Potì, 2009). In the final analysis, this means that signs reduce their polysemy by means of the communication flow in which they are implemented.

This way of considering discourse dynamics suggests the possibility\utility of regarding sense-making as a dissipative system—that is, as a process characterized by the presence of a strange attractor. We remember here that a strange attractor is a region of the phase space in which the trajectory of the system is confined. This means that the system loses most of the freedom of assuming the potentially infinite number of states theoretically available (represented by the point of the phase space outside the strange attractor). Yet, at the same time, a strange attractor is such because the temporal trajectory of the system always occupies a different point, never passing twice through the same point (see above, the concept of density of the orbit). Therefore, even if the strange attractor represents a constraint upon the infinite variability of the behaviour of the system, it is however an infinite set of states of the system: the system always has a new state, at the same time quite similar to the previous and to the subsequent ones.

Sensemaking and Strange Attractor

The observation made above seems to fit the case of the dynamic model of sensemaking that we referred to before. From this point of view the analogy with the strange attractor helps to understand more clearly how—by means of and through its very performance—sensemaking can reduce its polysemy, while keeping its nature of infinite semiosis (Eco, 1976) always necessarily producing new patterns of meaning. Let us look at this point in greater depth. Firstly we notice how the ongoing communication is regulated by and, at the same time, reproduces a generalized super-order meaning. Such a generalized super-order meaning works as the frame of sense of the intersubjective sensemaking, suggesting the production of signs and their interpretation (Salvatore & Venuleo, 2008). Thus, for example, the moral value attributed to my action works as the frame of sense regulating the way I will speak of the effects of my conduct and the way others will interpret my speech (i.e., if my interlocutor and I are within the frame defining my action as a right, highly valuable action, the underlining of its gratuity will be performed by me as a way of projecting the value on my identity—I do the right thing not because I am forced to do it, but because I am right).

Yet the recognition of the regulating role played by the frame of sense entails a potential paradox. On the one hand, the frame of sense cannot be seen as a fixed semiotic entity—a la cognitive psychology mode, established once and for all. If this were so, there could be nothing new: people would be forced to always use and interpret signs in the same way, and therefore instead of infinite semiosis we would only have an endless repetition of the given meaning. And it is clear that such a scenario is very far from reality, where signs mostly work as an open field of signification (Valsiner, 2007) whose interaction makes it possible to pursue ever new paths of sensemaking. On the other hand, seeing the frame of sense as changing with time means that it no longer works as a super-order frame, that is, as the anchor field according to which the signs are interpreted. In other words, if sign **a** has acquired its meaning according to its position in a frame X that can be subjected to unconstrained changes, then sign **a** would be absolutely polysemic—in the final analysis, uninterpretable. This would be because it could assume infinite positions, as many as the infinite possibilities for changes of the frame. And this eventuality is clearly far from the reality of communication, where as well as being able to create novelty, people are at the same time able to share to a certain extent the meaning of the sign.

From a general theoretical viewpoint, the issue highlighted above leads us to conceptualize sense-making as a complex hierarchical system that is however characterized by reciprocal feed-forward linkages between levels, at the same time working as a constraint on the others (Valsiner, 2007). However, the point at stake here is that however one wants to conceptualize the micro-process of sensemaking, we have to recognize that it must be variable and invariable at the same time, in movement and static. The reference to the notion of strange attractor comes to our aid, allowing us to deal with what could be an impossible conceptual task. As we have underlined, a strange attractor describes a dynamic system, by definition having a different state in each instant. At the same time, a strange attractor is a constrained region of the phase space, therefore from this point of view it describes a system that—on a different scale of observation—does not change its state.

To restate this in more formal terms, let us think of an arbitrary long discursive exchange between two or more people. Imagine we are able to map the temporal evolution of the meaning on a phase space with *n* dimensions, each of them depicting a significant characteristic of the meaning in a given instant *t*. Therefore, each point *x* of the space represents one of the infinite possible states of meaning in a given instant, as depicted by the corresponding *n* coordinate of *x*. A high polysemic process will be represented by an orbit occupying a wide area of the space. As the sensemaking reduces its polysemy, the trajectory mapping it will confine itself within a narrow region of the space. Yet, according to the infinite nature of semiosis, the meaning is never equal to itself through time. Therefore, even in the sub-region in which is confined, it always draws new trajectories. This means that it is working according to a strange attractor (one can find connections between this conceptualization of sensemaking in terms of strange attractor and the notion of Trajectory Equifinally Model, TEM, Sato et al., 2007, Sato et al., this volume).

An Empirical Depiction of Communication as a Dissipative System

Some of the authors of the present article have recently carried out a study based on a quantitative analysis of the communication exchange performed in a 124-session psychotherapy process (Gennaro, Salvatore, Lis, & Salcuni, 2008) which offers an empirical illustration of the dissipative nature of the intersubjective exchange.[8]

The study assumes the lexical variability—that is the way words are distributed through the sentences and then combined with each other—as the operative definition of the meaning (Lancia, in press). According to this methodological approach, the meaning can be depicted as the way signs combine with each other—that is, the meaning can be empirically described in terms of the patterns of word co-occurrences within the same time unit/piece of discourse. For instance, if the words *m*, *n*, *o* tend to be present together through the discursive exchange, then this co-occurrence is the reflex—therefore the index—of a given meaning being expressed. On the grounds of these methodological assumptions, a text can be transformed into a digital matrix with each utterance as a row and each type of word present in the text as a column. The binary content of the cell *ij-th* (0/1) indicates the absence/presence of the word *j* in the utterance *i*. Then the matrix is subjected to a Multiple Correspondence Analysis (LMCA), whose output is a matrix of factorial coordinates.

It is worth noticing that each factor numerically describes a specific piece of the lexical variability; in other words, a pattern of co-occurrence of words/signs within the utterance. More precisely, each factor is shaped in a dichotomic way: as an opposition between two patterns of co-occurrence. This means that when certain words tend to co-occur, then another cluster of words tend to be absent. Moreover, each factor is associated to a different degree with each utterance, according to how the opposition between the two contrasting clusters characterises the utterance.

[8] Details are described in Salvatore, Tebaldi, and Potì (2009), the study from which the investigation in question is a further development.

Table 1.1 An ideal example of a phase space describing the dynamics of meaning through time

Utterance	Factorial dimension a	Factorial dimension b	Factorial dimension c	Factorial dimension d
1	−0.001	2.001	−1.897	0.000
2	0.002	2.123	−2.101	0.001
3	−1.456	0.003	0.002	−1.344
4	−1.902	0.004	0.000	−1.999
5	−2.190	−0.089	0.102	−2.890

According to these statistical properties, each factor can be seen as: (a) a micro-component of the meaning—corresponding to a given pattern of oppositional association between words—that (b) qualifies each utterance to a certain extent. In other words, each row/utterance can be seen as the state of the meaning in a given portion of time (the time required to produce the utterance in question). This state is described by the row vector given by the values of all the factorial dimensions associated with that utterance. In conclusion, this means that the factorial matrix can be considered as the numerical representation of the phase space of the evolution of the meaning through the communicational exchange.

Table 1.1 shows an ideal example of a factorial matrix, with 5 utterances and 4 columns/factorial dimensions. As one can see, the first and second utterances are connoted mainly by the positive polarity of the micro-component of meaning b and the negative polarity of the component c; then a shift occurs, and the trajectory of the meaning moves toward a state—corresponding to utterances 3 and 4—characterized by the salience of the negative polarity of the micro-component a and d.

The study applied this methodology on the transcript of the communicational flow between patient and therapist of a good-outcome 124-session\4-year psychotherapy process. The factorial matrix obtained by the analysis presented more than 10.000 rows/utterances and 498 columns/factorial dimensions. More particularly, the analysis focuses on the association between singular micro-components. For this purpose, by means of further statistical transformations,[9] an index was calculated depicting the association between each main factorial dimension (those showing a higher level of lexical variability) and 14 blocks of psychotherapy sessions. The higher the index, the more the micro-component of meaning characterizes the communicational exchange carried out within the block of sessions. Figure 1.3 plots the trajectory of the relationship between two selected micro-components of meaning through the 14 sessions. Each point represents a given block. Each of the two coordinates represents the values of the association

[9] Firstly, the factorial matrix were segmented according to the 14 blocks of sessions. Secondly, each submatrix was subjected to a factorial analysis. In this way 14 second order factorial matrixes were obtained. Each of them had the first order factorial dimension as a row and the second order factors as a column. This means that the second order factors can be interpreted as the association between first order factors. Finally, each row-vector depicting a given first factorial dimension was transformed into a single value, through the computation of the Euclidean distance of the corresponding point on the phase space defined by the second order factors.

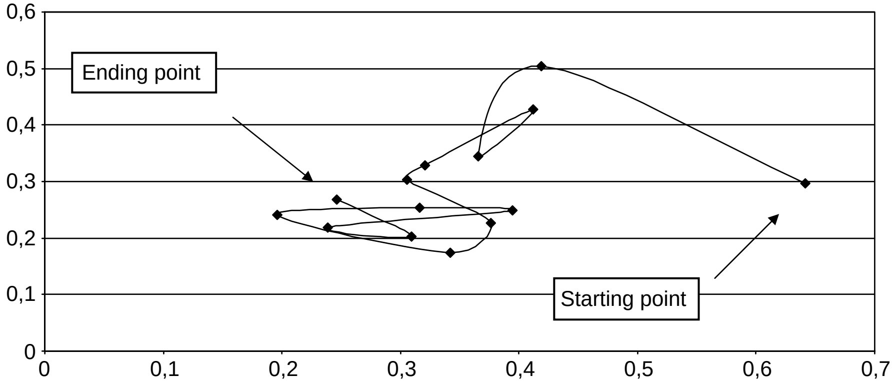

Fig. 1.3 The temporal trajectory of the association between two micro-components of sensemaking in psychotherapy communication

between one micro-component and the block. As one can see, throughout the time, the trajectory tends to confine itself to a sub-region of the phase space, the marker of the dissipative dynamics.

Self-Organizational Dynamics

Dissipative dynamics can be, but is not necessarily, associated with phenomena of self-organization, that is with the sudden formation of patterns reducing the variability of the behaviour of the system microelements—in the final analysis with the emergence of structures of order at the macroscopic level. In cases like these the dissipative dynamic can be seen as the reflection, at the macroscopic level, of the reduction in variability of the microelements' behaviour.

Evidence of Self-Organization in Psychological Processes

Tschacher, Schiepek, and Brummer (1992) focused on the phenomena of emergence in clinical psychology, referring to the synergetic as a conceptual framework and mathematical device for modelling self-organizational dynamics. The various contributors collected in the volume highlight how a wide range of clinical phenomena (the course of specific psychopathological conditions, the trends of symptomatology, the psychotherapy process) as well as other psychological aspects (cognition, perception, social and marital interaction) are characterized by processes of self-organization—that is of emergence of macroscopic order as a result of the enslaving of the microelements' behaviour.

Each of the previous examples shows that the non linear processes and phenomena of self-organization occur everywhere within the traditional areas of clinical psychology research and practice. In order to gain an understanding of the dynamic of evolution of such systems, theories of non linear systems and especially synergetic conceptualizations will be necessary in the future. It should be clear by now that the synergetic approach to phenomena treated by clinical psychology neither leads to physicalist reductionism nor means mere metaphorical thinking. (Schiepek, Tschacher, & Kaimel, 1992).

Working within the framework of the synergetic perspective, in a recent work Tschacher, Scheier, and Grawe (1998) (cf. also Ramseyer & Tschacher, 2006; Tschacher, Ramseyer, & Grawe, 2007) have modelled the non verbal communication between patient and therapist (concerning a good outcome psychotherapy) as a self-organizing dynamics characterized by the emergence of a synchronization of the two participants' movements. If one considers the infinite source of body movement as the microelements of the system, the synchronization can be seen as the macroscopic reflex of the enslaving of the microelements to an order parameter. From a complementary point of view, synchronization can be modelled as a reduction of the phase space dimensionality, in other words as a constraint on the possible infinite combinations of the behaviour of the microelements (in this case: changes in body position).

Interestingly, a very similar result is found by Salvatore et al. (2009) in their analysis of the verbal interaction between therapist and patient (see above for details). The study assumes that sense-making is a self-organizing system with the meaning emerging from within rather than introduced by outside. From the authors' theoretical standpoint, meaning can be seen as the constraints that the communication produces on the virtually infinite possibilities of combination of signs. According to this general assumption, at the very first moment (t_0) the communication between therapist and patient can be seen as a system with the maximum extent of entropy, that is characterized by the absence of any constraint on the freedom of signs to combine with each other. This condition is equivalent to saying that in the instant t_0 patient and therapist do not share any system of meaning and therefore are in a condition of perfect reciprocal strangeness, that is of maximum communicational uncertainty. Obviously this is a theoretical model: even in the first moments of their encounter patient and therapist have some shared symbolic background, simply because they are part of a cultural environment. Nevertheless, the development of the therapeutic dyad is one of the social phenomena that more than any other approximates the theoretical model of perfect strangeness.

Moreover, it is a form of social interaction whose development from the beginning can be easily described, in this case by recording the verbal communication. This makes it a good candidate for studying the sociogenesis of meaning. According to the authors' central hypothesis, in the first moments of the interaction between patient and therapist a system of shared meaning suddenly starts to work as the symbolic framework—what the authors call "frame of sense"—regulating the further communication—and once functioning, it goes on for all the rest of the time. This phenomenon can be viewed as a dynamic of emergence—and therefore the

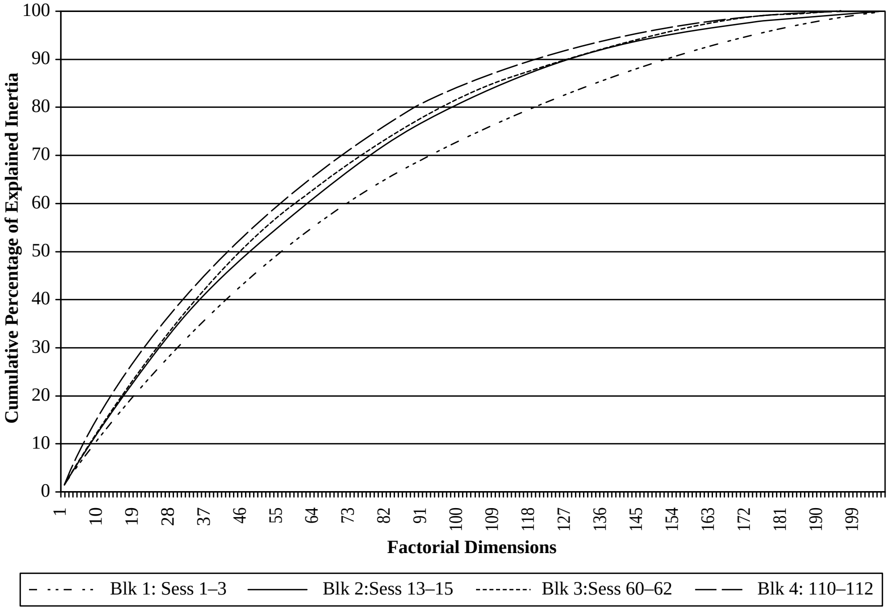

Fig. 1.4 Cumulative percentage explained by the factorial dimension extracted by the 4 LMCA

communication has to be seen as a self-organizational system—because it is not the product of a specific agreement between the participants (which would entail the subjects importing ready-made meaning from outside); rather, it happens from within the system, as a consequence of its functioning.

In order to empirically depict this emergence dynamic, the authors analysed the transcripts of a 124-session psychotherapy process. More particularly, they performed 4 Lexical Multiple Correspondence Analyses (LMCAs), each of them applied to the subset of the whole matrix sentences x words corresponding to a segment of the whole text, therefore to a temporal window of the psychotherapy.[10] This study is based on the same methodological approach and data set as that in Gennaro et al. (2008). However, unlike the former, the latter does not deal with the trajectory of the state of the system through time; rather, it focuses on the phase space dimensionality produced by the Multiple Correspondence Analysis.

For this purpose the authors calculated the distribution of inertia associated to the factorial components. As Fig. 1.4 shows, after the initial sessions (Blk 1) the phase space reduces its dimensionality. In other words, the lexical variability explained (inertia) tends to be concentrated on the first hundred factorial dimensions. This means that, for instance, in comparison with the first LCMA, the other 3 LCMAs (concerning block 2, 3, 4) need a lower number of factorial dimensions to explain

[10] A first block corresponds to the initial phase of the psychotherapy (sessions 1–3), a second block corresponds to an early phase (session 13–15), then a middle block (sessions 60–62) and an almost final block (sessions 110–112).

89% of the inertia. Moreover, it is worth noticing that the reduction of the dimensionality does not follow an incremental course. Rather, it seems more like a single jump that happens just once (between block 1 and block 2)—and then remains constant across blocks 2, 3, and 4.

The authors interpret this finding as evidence consistent with the hypothesis of the emergent behaviour of sensemaking dynamics. As matter of fact, in the final analysis the reduction of the phase space dimensionality means that after a while a constraint on the possibility of sign combination emerges in the dialogue. Once this happens, each sign loses some degree of freedom, being allowed to associate itself only with a subset of the other signs. In other words, after the first moment of discursive interaction, the communication places constraints on the possibility of combination among words, preventing some combinations, making others other improbable, and others more frequent. On a macroscopic level, this means the emergence of an order parameter that on the interpretative level can be seen as a frame of sense regulating the discursive exchange.

It is worth noticing that this phenomenon of emergence of a structure of order seems to be specific to interpersonal exchange. In fact, the study compares the verbatim transcription of the psychotherapy process with the text of a novel. In the latter case, the phase space dimensionality increases—rather than decreasing—after the first moment, to remain constant in the rest of the text. The authors interpreted this finding by highlighting that while in the case of interaction among people the participants can create a shared frame of sense by means of their dialogue, an already shared system of meaning between writer and reader is required in order to make the novel readable. Once the text is approachable, it can work as a source of novelty, allowing for multiple paths of making meaning—therefore creating an increase in semiotic variability.

Conclusion

In this chapter we have tried to show that psychological phenomena are to be seen as dynamic processes, because of their intrinsically temporal and developmental nature. The Mathematical Theory of Dynamic Systems can therefore be a source of useful approaches and tools enabling psychological theory to go beyond the reductive static conceptualization of its objects. In actual fact, the use of models coming from Dynamic System Theory (DS) has been spreading widely in various psychological fields (cognitive psychology, neurosciences, social psychology). In spite of its name, and more importantly, in spite of the characteristics of the phenomena it deals with, psychodynamics has left little room for this perspective. This is particularly true in the modeling of the inter-subjective processes of sensemaking. In our opinion, this results in the failure to grasp a major opportunity for development in the field.

It seems to us that two points are worth underlining in our discussion. Firstly, the dynamicity of the psychological process is not homogeneous. In fact, dynamicity has to be seen as a set of different concepts, within which an even larger number of specific models can be encountered. We have highlighted the fact that psychological processes are suited to a conceptualization according to different aspect/properties of the dynamic theory, which in turn is merely a single conceptual system. More particularly, we focused on four different types of dynamic behaviour relevant to psychological phenomena. As we have seen, some psychological processes are better conceptualized as the expression of periodic trends, that is, as linear yet redundant trajectories; some other processes are to be seen in terms of a non linear course, entailing models going beyond the use of the traditional techniques of analysis based on linear algebra. Yet other processes seem to show traces of chaotic dynamics, characterized by dependence on the initial condition and dissipative behaviour (presence of strange attractor). Finally, in other cases the models and tools of the theory of the self-organization system seem to be the most useful way of coping with the phenomena.

Secondly, according to our discussion, the variability among the different approaches mentioned above has to be seen not as the reflection of the intrinsic nature of the psychological phenomena in question. In this sense, it is not an empirical matter. Rather, it is a theoretical choice entailing the decision of what aspect(s) of the phenomena should receive more attention and which should be placed in the background. Obviously this statement does not mean that the mundane manifestations of psychological processes are irrelevant. Yet they work as constraints on the viability of the theoretical choice, rather than input regulating it. This last statement has an important implication: the possibility of once again considering methodology as a theoretical activity: thinking of how one has to model the scientific object according to the aim of—and the resources for—its representation.

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