Physics of Life Reviews 51 (2024) 64–84

Contents lists available at ScienceDirect

Physics of Life Reviews

journal homepage: www.elsevier.com/locate/plrev

Review

Nature heals: An informational entropy account of self-organization and change in field psychotherapy

Pietro Sarasso [a,*], Wolfgang Tschacher [b], Felix Schoeller [c,d], Gianni Francesetti [e], Jan Roubal [f], Michela Gecele [e], Katiuscia Sacco [a], Irene Ronga [a]

[a] Brain Plasticity and Behaviour Changes Research Group, Department of Psychology, University of Turin, Turin, Italy
[b] Department of Experimental Psychology, University Hospital of Psychiatry and Psychotherapy, University of Bern, Bern, Switzerland
[c] Institute for Advanced Consciousness Studies, Santa Monica, CA, United States
[d] Massachusetts Institute of Technology, Cambridge, MA, United States
[e] International Institute for Gestalt Therapy and Psychopathology, Turin, Italy
[f] Gestalt Studia, Training in Psychotherapy Integration, Center for Psychotherapy Research in Brno, Masaryk University, Brno, Czechia

ARTICLE INFO

Communicated by Gracia Lyu

Keywords:
Field-based psychotherapy
Free-energy principle
Synchronization
Biophysics
Entropy
Neurophenomenology

ABSTRACT

This paper reviews biophysical models of psychotherapeutic change based on synergetics and the free energy principle. These models suggest that introducing sensory surprise into the patient-therapist system can lead to self-organization and the formation of new attractor states, disrupting entrenched patterns of thoughts, emotions, and behaviours. We propose that the therapist can facilitate this process by cultivating epistemic trust and modulating embodied attention to allow surprising affective states to enter shared awareness. Transient increases in free energy enable the update of generative models, expanding the range of experiences available within the patient-therapist phenomenal field. We hypothesize that patterns of disorganization at behavioural and physiological levels, indexed by increased entropy, complexity, and lower determinism, are key markers and predictors of psychotherapeutic gains. Future research should investigate how the therapist's openness to novelty shapes therapeutic outcomes.

1. Introduction

1.1. Aims and scope

Psychotherapy is a complex phenomenon, that lacks a shared definition [1], and the scientific community still has difficulties grasping its principles of action [2]. Previous research tentatively defined psychotherapy as a cure, which unfold in the interaction between a therapist and a client, based on processes of learning [3], on specific therapists' core competences [4] and on the sensory perception following intrinsic aesthetic (related to sensory knowledge) criteria [5,6]. The therapeutic dyad or group self-organizes and reorganizes into more and less stable relational patterns [6–14] and destabilizes and transits into novel patterns [15]. This non-linear [11,14,16–18] process is favoured using approach-specific techniques (e.g., cognitive reframing, exposure and response prevention, behavioral activation) and other therapeutic factors that are common across different approaches [19–23]. Applying complexity science and biophysics to the description of human change during the psychotherapy process can be a useful tool to support

* Corresponding author.
E-mail address: pietro.sarasso@unito.it (P. Sarasso).

https://doi.org/10.1016/j.plrev.2024.09.005
Received 28 August 2024; Accepted 4 September 2024
Available online 6 September 2024
1571-0645/

"trans-confessional" macrotrends in psychotherapy [24]. The current interests in psychotherapy research shared by different orientations include the attention to the flexibility of therapeutic plans [25,26], the intrinsic and moment-by-moment evaluation of therapeutic intervention emerging from the context [5,27–29], the therapist's self- awareness of her/his inner states and the involvement of the therapist's self [30], interoceptive awareness [29,31], intercorporeality and embodied resonances [32–34] and interpersonal attunement [35]. Moreover, current research in psychotherapy is growingly interested in the physiological and behavioural synchronization between therapists and patients [36], the synergy between pharmacology and therapy [37,38], and stochastic change processes [9].

Most importantly for the aim of the present paper, complexity can support the move from inter-subjectivity to a "field-based" perspective [20,39–52]. Field-based intuitions, such as the psychoanalytic concept of "analytical field" [50], constitute a "new paradigm" [53] in contemporary psychotherapy that is paired with a transformation of the epistemology and clinical posture in psychotherapy [50]. Indeed, there is a growing interest on the common, pre-subjective and undifferentiated phenomenal field from which the patient's and the therapist's experience co-emerges [46]. However, as highlighted by previous research: "a question eventually becomes unavoidable. Is 'the field' ultimately just a metaphor, a useful derived concept and framework that can be used to explain what is difficult to explain? Or is 'something there' in the form of an explicit energy field in the 'space between'?" ([54]; p. 60). Is change determined by the therapist's intervention or is the result of field forces that transcend individuals?

Recent work by Tschacher and Haken [8] offers an interesting perspective on a core healing mechanism of psychotherapy. Rooted within systems science, their main idea is that change in psychotherapy processes can be described in terms of two distinct dynamics. Therapeutic interventions become effective by the interplay of deterministic ('causation') and stochastic ('chance') forces. Deterministic processes refer to the change in the client's behaviour or subjective experience in a particular and predetermined (desirable) direction – for example, the depressed client starts to experience pleasure again. On the contrary, stochastic change processes refer to a wider exploration of the states the patient can be in. That is, during the course of therapy, the client may experience a greater range of thoughts, behaviours and feelings in a way that it is not possible to predetermine (yet intrinsic to the phenomenal field emerging from the patient-therapist interaction; see below). Thus, therapy involves phases of enhanced flexibility, "in which entropy is high, emotional language is high, a new perspective is entering within the psychotherapeutic relation" [[55];p.6). Thanks to stochastic change the therapeutic couple's conscious experience can escape being 'stuck' in a particular range of relational, perceptual and affective experiences. As previous accounts of psychotherapeutic change have already highlighted, psychotherapy "proceeds to accompany the patient […] to feel the not felt"([56].

Based on the intuitions derived from the Free-Energy Principle (FEP, [57]) and previous theoretical accounts, in this paper we suggest and set out to defend the following hypotheses to better understand stochastic change processes:

Table 1
Clinical examples. Here we present two cases where the therapist's epistemic trust allowed for surprising sensory/affective states. Surprising sensory states became more predictable, while the phenomenal landscape of attractor and avoided states changes and opens to novel relational experiences.

Clinical example 1.

The client, Alice, is a 35 years old woman. The therapist has been meeting her on a weekly basis for about six months. She doesn't feel a good therapeutic alliance. This creates a discomfort for her in the sessions together with a sense of duty to try harder or to do more. Without any success. The therapist perceives herself as working on an auto - pilot mode, being supportive by saying the 'right' things while she recognizes in her no sincere involvement in the process. The therapist also starts picking up a sense of stickiness surrounding Alice (during the session and afterwards). It is similar to the experience of the skin of children, who have played outside for hours and are a bit dirty; or have eaten sweets and some of this sweat and sweet is on their skin, sticky and with a little bit of dirt too. The sensory experience is focused mostly on the sense of touch, she would not want to touch Alice although her appearance is not neglected or repulsive in an aesthetic – cosmetic sense. She also realizes that she does not want to touch the couch Alice was sitting on, while she wants to wipe it, in order to prepare the room for the next session. Starting from this sensory experience of stickiness and exploring it the therapist arrives to recognize an unconfessable feeling of disgust. At the same time a wave of shame invades her for feeling this. The therapist notices that disgust is a healthy immediate bodily repulsion that protects the organism from being poisoned. She connects this feeling with the history of Alice: she is a second child in the family of four (two parents and two children). Alice's ten years older brother has been a heavy drug addict from his teenage years and was later diagnosed with schizophrenia. Alice had to take care of herself from very young age, emotionally supporting both sides, her parents and her brother. It seems there was no space to express disgust: this was probably never recognized nor named and a boundary to protect family members from what is poisonous was not set. Disgust was not legitimate.

Parallel to this, the therapist's feeling of disgust was "not allowed" during the therapy sessions: she just wanted to get rid of these feelings – inappropriate for a 'good therapist'.

This awareness is accompanied with a wish to explore the issue of disgust in Alice's life.

The session ends.

In the next session, the therapist immediately perceives Alice differently: her face illuminates and her hands are cleaner. She is very surprised; she even puts on and off her glasses to see better, look somewhere else and look back at her – still lighter and cleaner. The "sticky" feature seems to be gone. She almost doubts her own perception.

She feels lighter as well and more ready to just accompany and not try so much. They talk about Alice's dance classes, the small ballerinas she teaches, and a sense of joy, purity and innocent beauty is in the room today. This lightness is a great novelty, not only in the session but also in client's life. Then, they explore the history of boundaries in Alice's family and in Alice's relationship. A feeling of a heavy burden in Alice's chest is now recognized, and connected with the role she had to play in her family.

Clinical example 2.

A psychotherapist with a depressed client experiences body heaviness, fatigue and general inhibition. Together with the client, they are thus "drawn" into the depressive experience. Regardless of the spoken content of the session, the therapist also experiences helplessness and hopelessness, because the depression stays the same during the session.

However, when the therapist approaches herself in a self-compassionate way, not blaming herself for her experience or fighting against it, it allows her to feel the pain and sadness. This is also what the client will see when he looks her in the eye. And he, too, thanks to the therapist's compassionate co-existence, can now step out of his depressive numbness and feel the pain and sadness. Tears appear in the client's eyes, and he can step out of the vicious circle of depression into the healing process of grieving.

1) Free-energy minimization creates a sensory state-space of more or less probable sensory/affective phenomena (phenomenal field), that can be visualized as a landscape with valleys (predictable states) and mountains (surprising states). Free-energy minimization then acts like a gravitational force attracting sensory experience towards the bottom of valleys. A psychopathological pattern of feeling, thinking, and behaving can be seen has an attractor state or valley.
2) General synchronization implies that whenever two free-energy-minimizing agents, the therapist and the patient, are sensorily coupled they begin to share a phenomenal landscape. Therefore, their experiential possibilities are governed by a common relational field of free-energy gradients.
3) Therapy aims at changing the relational, phenomenal field by allowing surprise to enter the system and reorganize it into novel attractors and patterns. This is done by embracing surprising sensory/affective states, previously residing outside the homeostatic boundary (and therefore less probable to be felt) and integrate them in the shared predictive representations of the sensory environment. In analogical terms, to use Friston's metaphor of annealing in metallurgy [37], surprising states heat up rigid phenomenal fields (i.e. the brain's free-energy landscape) that transitorily melt down and flatten the distance between valleys and mountains. This momentary plasticity allows the system to move outside its usual attractors.

We provide two clinical examples of this process that we will refer to in the present paper in *Table 1*.

1.2. Suffering and psychotherapy as syntropic complex phenomena

Physics of life sees life as a negentropic/syntropic phenomenon [58,59]. Life, as suggested by Erwin Schrödinger, and further developed by Luigi Fantanppié, is delayed entropy; an organism "… feeds upon negative entropy, attracting … a stream of negative entropy upon itself, to compensate the entropy increase it produces by living and thus to maintain itself on a stationary and fairly low entropy level" ([59]; p.73). Theories of complexity, such as Prigogine's dissipative structures, Haken's synergetics [60], Bak's self-organized criticality [61] share the idea of "organization maintained by extracting order from the environment" ([59]; p.73). Similarly, as suggested by the widely popular unifying theory of cognition, the FEP [57], organisms strive to preserve their internal order (i.e., configurational entropy) in a world that irremediably tends toward disorder [62]. Sensory perception and motor action give rise to an information/energy exchange [63] with the environment [64] that tries to reduce the (Shannon) informational entropy [65]. However, some organisms, especially humans, may paradoxically allow transient entropy increases inside their system by spontaneously seeking and creating change instead [66–68]. The price to be paid for any internal import and accumulation of entropy is a transient loss of structure [69,70].

Suffering and psychological crises that drive people into therapy can be seen as intentional phenomena [71] motivated by the same entropy-reduction principles [72]. In recent decades, a novel view of living systems has emerged departing from the traditional view of life as a mere homeostatic system striving for some form of dynamic equilibrium, where they are conceived instead as "extended critical transitions, always transient toward a continually renewed structure" [73]. When dynamical systems self-organize into fully developed and stable attractor patterns with a high probability of activation, patterns acquire increasing *rigidity* and become relatively insensitive to disturbances or new information [15]. This state has been repeatedly compared to psychopathology [74]. Nevertheless, as any self-regulating (autopoietic) biological system [75], humans are intrinsically oriented towards growth [76,77] and, sometimes led by peripatetic dynamics and crisis, they may disrupt their habitual (and eventually psychopathological) action policies to integrate and create new dynamics [72,78–81]. However, therapeutic transformations are rarely achieved in solitude, while it seems that we must encounter others to change, to feel what we alone cannot feel [82]. The aim of this article is to integrate complexity science, biophysics and phenomenological accounts of human change, in order to shed new light on how the therapeutic encounter can introduce new degrees of freedom in self-organization. By doing so, we arrive at a better understanding of interventions and mechanisms that can disrupt and modify the entrenched patterns of emotional, cognitive, and behavioral rigidity known as "psychopathological attractors" [12,83].

The present manuscript is organized in three sections as follows. We will first define the subject of therapeutic change and thus the object of our inquiry. Second, we will describe change via self-organization through the lens of synergetics and the free-energy principle as the change mechanism. Lastly, we will discuss which attitudinal factors can trigger metastable attunement and change (i.e. the motivation for change).

1.3. Synchronization and merged intentionalities

1.3.1. Gravity without a centre: the pre-subjective phenomenal field

Before addressing change, we need to clarify what the field perspective defines as the subject of change (and self-organization). Who (or what) is changing? The patient or the superorganism composed of both patient and therapist, or even beyond this the social system of organisms that interact with both in daily life? What is the extension of the therapeutic field?

Following a long tradition of medical epistemology, mainstream psychology and psychiatry usually consider the patient's symptoms and illnesses as the object of therapeutic intervention. This is a shift from an older tradition, which considered the person as the object of medicine (the Hippocratic tradition). A more recent turn in psychiatry focuses on the relation between patient and caregiver, constituting a bi-personal approach where change is observed at the level of the relation within the therapeutic dyad. Besides these mono-personal and bi-personal approaches [20,84], more radically relational field-based interventions focus on that thing "that emerges in the between" [85]. Such "field approaches" suggest a therapeutic approach were both the therapist and the patient "get sick" and start to heal as soon as they encounter. It is the phenomenal field that needs healing not simply the patients or their illness: it is not you and I who are making the change, but field forces greater than the therapeutic relation itself [84]. Healing is the gradual process of change in the shared phenomenal field, which governs the action and perception of both therapist and patient within the context of psychotherapy. It follows that psychotherapy might not act at the scale of the single individual, and its effects are to be observed and studied at the field level. Consequently, we refer to the patient-therapist dyad as a single self-organizing system. Shifting the focus from the individual mind to the situated collective interaction dynamics is currently a central debates in cognitive science [86]. There is a growing consensus on models of cognition as a process involving interacting and dialogically extended minds, leading to fundamentally new approaches that put system interaction at centre stage [87].

Systems science has become a prominent framework for the study of therapeutic change [88]. This is precisely the focus of field-based clinical practice: the pre-subjective self-organization processes at the therapist-patient-environment system level. The reason for focusing intervention on the pre-subjective relational level, a relation that precedes the relates [89], rests on the recent epistemological shift brought by neurosciences suggesting that no abstract subject exists outside sensory encounters with the environment. On the contrary, the self is a process constantly emerging from perception [77]. Self and world both emerge from a stage of perception that is originally undifferentiated [90–92]. Recent studies highlighted that subjectivity, selfhood, comes to mind only at a second stage of perception [93]. Minimal self is an inference drawn from having sensations [94–96]: phenomenal selfhood is seen as an hypothesis or latent state (of being) that can be associated with a self-model. This component of a generative model (the predictive model representing the causes of sensations) arises as the most parsimonious explanation for bottom-up multisensory information [97–100]. In short, "being there" is just the best explanation we have to being immersed in a sensory whole, to having sensations, these latter being attributed to the self or to others only at a second stage of perception. Since subjectivity emerges from the exteroceptive and interoceptive sensory encounter with the world and the body [101], any scientific account of psychotherapy must adopt an epistemology that does not hold subjectivity for granted and possibly sheds new light on pre-subjective phenomena.

1.3.2. Duet for one: general synchronization and the hive mind

Western thought has long been interested in superindividual cognition [102]. Just to cite an eminent example, according to Schopenhauer "individuality is an illusion [*Maya*]. Like other animals we are embodiment of universal Will" ([103]; p.41). In the hearth of the 20th-century, the interest in combined consciousness at scales beyond single minds has been accompanied by a parallel notion that groups of discrete individuals constitute Gestalts distinct from the sum of their parts (group-as-a-whole systems theory; [104]) as suggested by the contributions of Wilfred Bion, S. H. Foulkes, Ervin Laszlo and Kurt Lewin, among the founders of system theory. After some decades of silence, research on superindividual cognition is once again gaining momentum. This renewed line of research is still deeply influenced by Kurt Lewin's field theory of group dynamics [105] and has become operationalized in experimental psychology through such concepts as intergroup emotion theory [106] and "collective intelligence factor" [107]. According to the field perspective, not only "being" is situated, but also our perceptions, actions and intentions depend on the pre-subjective phenomenal "field forces" [108,109] we are caught by [110]. Field forces can be referred to as intentionalities: intrinsic tensions moving towards the fulfilment of the potentialities of the situation [6,84]. We are "being moved" [111] before we move. To use a common figurative expression of field theorists, there are forces in a phenomenal field that wait for a body that allows them to emerge [20,89,112], thereby extending pre-subjectivity beyond the less radical intuition that "the processing of one's own body can, thus, include signals from the body of the interaction partner" [113]. In short, within a system or field of sensorily coupled parts we are being synchronized and coordinate with other parts as a whole [114]. Synchrony indeed is not just the outcome of sensory coupling but might underlie psychic combinatory processes. Based on the General Resonance Theory of consciousness [115], Young and colleagues [116] suggest that person-to-person synchrony implicates the combination whereby sensorily coupled agents merge into a common cognitive system to which they are subsidiary. Although not new, these intuitions still lack solid formal grounds and empirical verifications which might be provided by recent applications of self-organization theories at larger scales than the single mind.

The typically human motivation to align mental states and goals with those of others [117], to fulfil the "adaptive prior that one's mental states are aligned with those of conspecifics" ([118] p.6), through mirror and resonance systems [119] is not sufficient to explain what contemporary computational neuroscience suggests: that shared system dynamics precede the emergence of single minds (action, perception, intentions). As an example, recent neurocomputational concepts such as general-synchronization of generative models [114], have been discussed within the FEP framework, which is nowadays increasingly situated within multi-scale (social) interactions, beyond the individual agent level [35]. Free-energy minimization indeed is not limited to single minds, instead its principles can be applied at multiple scales to understand the organizational properties of complex biological systems, from plants and single cells all the way up to humans, and the social networks they form with each other [57,62,100,120]. As explained in Friston's seminal paper "a duet for one", because of general-synchronization, as soon as two organisms are sensorily coupled their self-organization process becomes unintentionally shared [114]. Conceptually, this is similar to a Bayesian account of mirror neurons [121] in which shared generative models (the predictive model that maps the correspondence between sensory data and their causes; see §2.1) are used to both produce action and infer the intentions of actions observed in others [114,122].

General synchronization is a specific case of more generic laws describing how patterns of coordination and "collective states" [123] in neurobehavioral systems emerge as macroscopic properties from microscopic self-organization dynamics [123]. These dynamics are captured by the concept of "multiscale integration", i.e. the fact that self-organization occurs at nested spatio-temporal scales, from the micro up to the macro. This theory relies on the notion of multiple and parallel nested Markov blankets (the statistical boundary that separates the organism's internal and external states; [57]) at different spatio-temporal scales, thereby implying that a symbiotic cognitive system shows a plurality of ontological boundaries [102]. One free-energy landscape located at one spatio-temporal scale is simultaneously composed of other nested free-energy landscapes constituents at the scale below and is itself a constituent of a larger free-energy landscape at the scale above it. The free-energy minimizing dynamics of macroscale systems (e.g. an organism) constrain the dynamics of the microscale systems (e.g. single cells), that share the same generative model [124–126]. The macroscale system acts as an order parameter for the microscale system [127,128].

In parallel, pragmatist applications of the FEP to the study of cooperative communication began to consider interacting agents as a self-organizing dynamical system and reached similar conclusions. These efforts have led to the notion that "human communicative interaction is a way of constraining interaction dynamics toward the goals of a given joint action by constructing and altering shared fields of affordances" [129], alternatively defined as "we-space" [130]; as soon as humans start to communicate, they begin to share expectations and to navigate and constantly shape and reshape a shared field of affordances [131] on which they can act to jointly minimize free energy [129]. In other words, as coupled agents begin to share their generative model they start to move within the same phenomenal field of more or less probable states. As some researchers have recently noted [132], the general synchronization into a shared generative model might be a fundamental precursor of psychotherapeutic change.

Altogether, this complex body of research is producing a radical epistemological shift in how scientists and clinicians describe therapeutic change. The study of coordinated and synchronized patterns of self-organization in system dynamics has begun to influence psychotherapy, mainly psychoanalysis. As an example, starting from Friston's notion of shared self-organization process some scholars suggested that "psychotherapy can be considered as the meeting of two Bayesian brains which, in order to improve their respective predictions, must agree sufficiently to progressively refine their generative models. This permits a second step of 'mixing' of the psyches that goes beyond a simple tuning" ([56]; p.5). We previously defined this process as "Merging Predictions in the Pre-subjective Chaos" [6]. Connolly [132] further notes that in psychotherapy: "the emergence of this synchrony involves a dissolution of boundaries between the two participants where the sensory input from one becomes the prior of the other, as if it emerged from within" (p. 9). Holmes [133] similarly explains that "the energetic boundaries between them [patient and therapist] are temporarily dismantled. Together they build a shared brain or niche" (p. 57). This shared experience evokes what is called the "analytical field" in psychoanalysis (which we here refer to as "phenomenal field") which evolves beyond transference and countertransference and "implies a state of psychic regression for the therapist and the patient in order to produce enduring processes of transformation" ([56] p.5).

1.3.3. Objective and subjective definitions of the field

We base our shared "field forces analysis" [108] on different levels of description, both from the objective physicalist and from the subjective phenomenal point of view. Notice, as an example, how the definition of the phenomenal field provided below resembles Friston's homeostatic boundary of more predictable states [57] discussed in the second paragraph. To trace a parallel between the physical and the phenomenal is the task of enactivist neurophenomenology [134]. Other than most neurophenomenological investigations, we do not aspire at establishing a causal relation between the physical and the phenomenological (the so called "hard problem" of how consciousness originates from the physical), we rather assume that the same phenomena can be described at the subjective and objective level. Structural sciences, such as system science, address relations between formal objects independently of their content or ontology [23]: both experiential and objective data (e.g., neurophysiology or behavioural research) may inform structural models. The structural "point of view" oscillates between a first and a third-person perspective. Nevertheless, experiential or objective data may serve as the components of structural models. In other terms, "structural models suspend the categorical difference of first- and third-person descriptions" [23].

However, we believe it is best for a deeper insight to maintain a good balance between the two descriptive domains. As Kurt Lewin said: "One of the basic characteristics of field theory in psychology is, as I see it, the demand that the field that influences the individual should be described not in 'objective physicalist' terms, but in the way it exists *for that person at that time*" [108]. Accordingly, it must be kept in mind that the sensory states field and the associated gradients of objective (information-theoretic) quantities that we will describe throughout the paper and depict in figures, nevertheless correspond to a phenomenal field, where by phenomenal we mean the lived sensory/affective experience of the subject from the first-person perspective. Then, what is a phenomenal field?

According to previous definitions: "the phenomenal field is the horizon of phenomenal events for a given situation. It provides the border within which certain experiential phenomena tend to emerge, while others do not. It can be considered as the here and now horizon of the probable emerging forms" ([84]; p.3). As well as a horizon in a landscape that changes when we move a step, it is transitory, and it continuously changes according to any momentary attentional and dispositional change of the involved subjects. The phenomenal field can be felt by the therapist as an atmosphere (i.e. an emotionally attuned space), where certain behavioural, perceptual patterns and sensorimotor and affective resonances circulate at a pre-subjective level. The more pathological the field is, the more the therapist's experience is attracted to rigid recurrent patterns of relational themes, behaviours, thoughts, affects and sensations.

In the next paragraphs we will discuss how we can conceptualize this map or landscape of probabilities associated to sensory experiences in a neurocomputational framework.

2. Self-organization and change

2.1. Free energy principle: at the crossroad of surprise

2.1.1. The free energy principle (FEP)

The collapse of the empiricist paradigm urged to consider organisms (and minds) in terms of their complexity, emphasising their self-determination and self-organisation. Psychotherapy as well began to focus on the organism's active, open, projective [135] and plastic course of evolution and growth [77,136,137]. The FEP ideally supports this paradigm shift since it considers the cognitive system not as a passive information processor, but as an enactive [138] foreseer of reality.

The FEP is nowadays one of the most accredited theory in the cognitive sciences. Basically, it says that the cognitive system – whatever we do, think, and feel – is directed toward the minimization of sensory entropy, here called free energy. The premise of the FEP is that, for a living system to exist, it must maintain its states within a certain homeostatic boundary, while avoiding the dispersion of its states. In other words, to remain alive a self-organizing organism, or in general an open dissipative system, needs to counter-balance the second law of thermodynamics (i.e., entropy increases over time in closed systems). More precisely, the repertoire of physiological and sensory states in which an organism can be found is limited. Mathematically, this means that the probability of these (interoceptive and exteroceptive) sensory states must have low entropy; in other words, there is a high probability that a system will be in any of a small number of states, and a low probability that it will be in the remaining states. Entropy indeed can also be computed as the average self-information or 'surprise' (the negative log-probability of an outcome). Here, 'a fish out of water' would be in a surprising state (both emotionally and mathematically).

This means that any organism has to minimize its long-term average surprise (i.e., Shannon entropy) over the states it visits. Surprise is an information theoretic quantity that can be approximated with variational free energy [139]. Indeed, a self-organizing system in a stochastic and inherently ambiguous sensory environment cannot minimize surprise directly - this would require unmediated access to the actual state of the world. Instead, it can only infer (through a process called Bayesian inference, *Fig. 1A*) the causes of sensation so to minimize its "free energy", a quantity derived from statistical physics and information theory that defines an upper bound to the average surprise of sensations, given a certain model that maps from causes to sensations called generative model of the world [140]. Under reasonable assumptions, free energy corresponds to prediction errors (PE), the difference between the expected and observed sensory inputs. In short, every organism conforms to the imperative of minimizing the surprise associated with the states it encounters and it does so in the short term by minimizing the discrepancy between predictions and sensations, i.e. PE.

One of the main intuitions of the FEP is that surprise minimization is what inevitably and involuntarily creates regions of more and less surprising sensory states that characterize the phenotype and econiches of living beings, or we could say its personality and social habits, in the case of a human being (*Fig. 1B*). I.e., self-organization creates a field of sensory experiences with attractor states (more

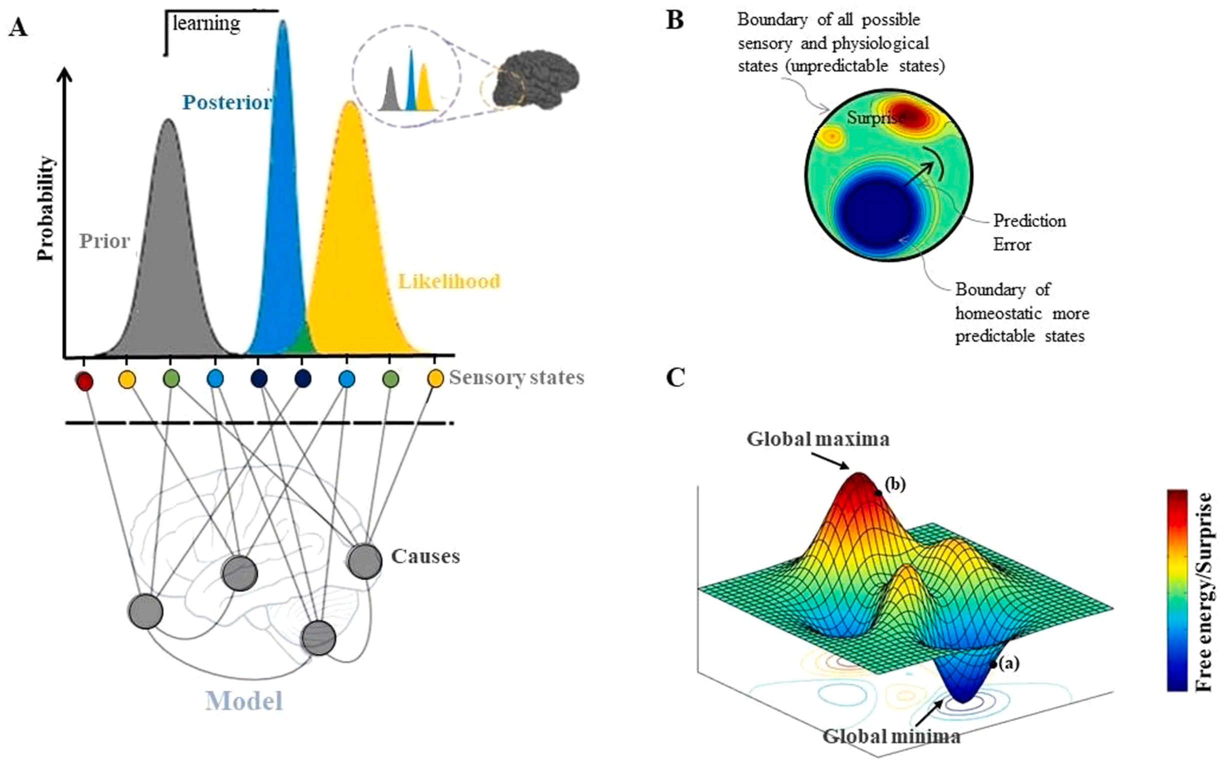

Fig. 1. Bayesian inference and the field of sensory states. In **panel A** we depict perceptual learning as Bayesian inference under a Generative Model mapping from hidden inferred causes of sensations to sensory states. Each perceptual cycle updates prior predictive distribution based on the sensory likelihood conveyed by incoming sensory inputs. The posterior probability associated to sensory states defines regions of more and less surprising sensory states that define the econiche and phenotype of living organisms as shown in **panel B.** Homeostasis tries to reconduct actively sampled sensory states within the boundary of more predictable states which can be visualized as attractor states and local minima in the sensory/affective states-space (**panel C**). The field of sensory experience maps regions of higher surprise associated to sensory and physiological states (in red), as it can be precipitating in free fall or being under water for a human organism, and regions of lower entropy, where the organism is more likely to be attracted, e.g. standing on solid ground. The sensory experience at point (a) is therefore characterized by lower PE, while larger PE are conveyed by sensory states at point (b).

predictable) and more informative (less predictable) states associated to increased surprise (*Fig. 1C*). This autopoietic [120] process of seeking a limited number of "attractor" states is somewhere referred to as local ergodicity [141]. Organisms are attracted toward steady-states that minimize surprise (free energy). The minimum of free energy, however, must not be understood as "at a point in which the agent is maximally adapted to the statistics of a static environment, but can better be conceptualized an attracting manifold within the joint agent-environment state-space as a whole, which the system tends toward through mutual interaction" [40]. The free-energy function can be visualised as a landscape or a field with valleys (attractor states) and hills, highly surprising repulsive states that might be crossed only for reaching a deeper valley [142]. In this landscape analogy, just like gravity, free-energy minimization attracts experience toward the bottom of valleys, thereby ensuring that the organism's habitual mode of self-regulation remains intact ([143]; p.311).

As we mentioned in the previous section, as soon as two or more singularities couple into a larger system, their sensory state-space characterized by their free-energy gradients (i.e. phenomenal fields) become shared. As a result, one single field and a unique shared map of free energy gradients emerges and guides the system as a whole. Indeed, to provide an example within psychotherapy research, a superindividual field representation can describe dyadic relational therapeutic fields as in De Felice et al. [144]. When applied to psychotherapy, one should intend the field represented in *Fig.1C* as something that guides the relation between the therapist and the patient and determines which experiences are more or less probable to encounter in their relational field.

2.1.2. Bayesian active embodied inference

Top-down predictions and bottom-up prediction errors (PE) are computed by the brain by solving a complex *Bayesian inference* problem [145,146]. Perceptual inference operates under hierarchic generative models of the hidden or latent causes that underlie the observed sensory data. To maximize the evidence of the models of "what is out there" PE are minimized by converting prior beliefs into posteriors which align with newly sampled data likelihoods (*Fig. 1A*). The *posterior predictive distribution* describes which data you should expect to observe, given the model you've assumed and the data you've collected so far. The *prior predictive distribution* tells us what data to expect, given our model and our initial beliefs about the hidden (latent, unobservable) parameters. The prior is a distribution over data and describes the relative probability of different observable outcomes before we have seen new data.

The generative models that inform us on "what is making us feel what we will feel and sense" are predictive internal models of our body in the world [147–149]. I.e., they are not to be intended as strictly cognitive-perceptual beliefs, but are enactive, embodied and affective models including beliefs about ourselves [150], our future action plans and models of the causes of affects drawn from proprioceptive and interoceptive inference [151]. The expected sensory outcomes, thereby, include the interoceptive and exteroceptive outcomes of planned actions. The term "active inference" is often used to stress the fact that action is integral to the inferential process [152]. Acting means to change the sensory likelihood to make it as much similar as possible to priors.

Sensory predictions also involve interoceptive/affective body-states. The FEP sees interoception in terms of embodied predictive processes that support emotion and selfhood [97,148,149,151,153,154], which is particularly interesting for psychotherapy and psychopathology [155]. Indeed, according to this Bayesian brain hypothesis there is no formal distinction between cognition and emotional processing [149,151,153]. Emotions, as any other sensation, are part of our ability to comprehend the situation we are in during the energetic exchange with the environment. The only difference is that emotions are based on interoceptive inference rather than on distal perception. The sensory organ in this case is our body, resonating with the present situation like a sounding-board [34]. Prior predictions are not to be intended as merely cognitive beliefs, or as internal representations inside a brain that is separate from the body and the environment, but rather as embodied, affective and enactive models of what is more and less probable to feel, sense and do. Prior predictions are models of the self/environment that prescribe our "being in the world" and in turn are questioned and updated by the attunement to an intracorporeal and affective resonance space, in circular causality [156]. According to this framework, human interaction does not necessarily imply mentalization (attributing propositional mental states to others) as hypothesized by the Theory of Mind, but relies on an innate sensitivity to bodily cues [157]. Intersubjectivity is immediate and emerges at the level of perceptual experience and mirror-mediated bodily resonance [158–160]. The "constitutive coupling" of subjectivities happens through the formation of "larger dynamical system so that joint body schema belong only to this larger system" ([161]; p.53)

In sum, from an enactivist standpoint, we can imagine the sensory state-space represented by a field of free energy gradients as a "hot" affective and embodied field, as opposed to a "cold" merely cognitive and disembodied internal representation of the external world and others [157]. Such predictive phenomenal field involves our body and affectivity and is constantly updated by interoceptive inference. Moreover, such inference is "active" [162–165] since it involves the active sampling of sensory data through our actions. Generative models thus include "bodily schema" [85], our kinaesthetic and sensorimotor grip on the world, and our social "habitus" [166]. That is, a phenomenal field can be seen as a field of affordances [39,40]. We actively determine (i.e., enact) our phenotype and econiche by maximizing the evidence of our self-environment model. In a sense, we are embodied models of our world [6].

2.1.3. The surprise crossroad

According to the FEP, as it can be derived by a formal mathematical treatment [57,167](Colombo and Wright, 2021; Friston, 2010) there are two complementary strategies under the common goal of minimizing surprise. The difference between predictions and sensory states can be suppressed by changing the world or by changing the mind. "Agents can suppress free energy by changing the two things it depends on: they can change sensory input by acting on the world or they can change their recognition density by changing their internal states. This distinction maps nicely onto action and perception" ([57]; p.3). Namely, at any moment an agent can choose to minimize the same quantity (i.e., PE) either (i) by changing the predictions, that is, updating the prior beliefs embedded in the internal model of the world to account for the actual sensory input or (ii) by acting upon the world, in order to sample sensory states that make a better match for the agent's predictions. In other terms, the mind constantly oscillates between the homeostatic Freudian "effort to keep constant or to remove internal tension due to stimuli" ([168]; pp. 55–6) through the active selection of sensory states and Heidegger's "ek-sistence" [71,135], its inherent allostatic openness to the world.

Musculoskeletal and visceral reactions both outside in the world and inside the organism as well as complex planned actions try to change the world to make actual sensory states identical to predicted sensory states [57]. When we act, we generate a prediction of the "desired" sensory outcome that we expect to result from the selected action. We fulfil this prediction by executing the intended movement. By doing so, we suppress a predictive error signal (i.e., we reduce the likelihood of sensory states indicating the mismatch between current and desired states of the world) that would otherwise emerge [57,169–171]. Pragmatic action reduces the difference between the current and the goal states [154] that are defined by prior expectations (i.e., the desired outcome of the action; [172]). Active inference does not rely on action and movement exclusively but includes other kinds of active sampling of sensory states such as drawing attention away from sensory states that diverge from predictions, i.e., anesthetisation and mental action. In this way, with mental or bodily action, we re-enact and re-embody fixed pattern of behaviour, feeling and thinking. Except for epistemic actions such as exploratory behaviours, active inference is a homeostatic process that maintains our internal and external milieu as predicted. That is, "by acting on the environment to minimize the free energy of their sensory samples, biological systems would avoid surprising sensory states. If they avoid surprising sensory states, biological systems may attain a homeostatic state" [167]; p.3473). In this case, the surprise conveyed by the discrepancy between expected (or desired) and actual states of the world is not welcomed and assimilated but is "thrown back in the world" through movement aiming at reducing the discrepancy. Action is a way to actively reduce the evidence of unpredicted sensory states and maximize the evidence of the predictive internal model [57].

The generative models tend to maintain their own organization (i.e., to maximize its evidence) as far as possible [173], even at the cost of repressing meaningful information to do so [174]. Homeostasis, however, is not the only characteristics of life. There is a whole class of other phenomena governed by entropy/surprise influxes triggering self-organization involving dramatic changes (e.g., from a

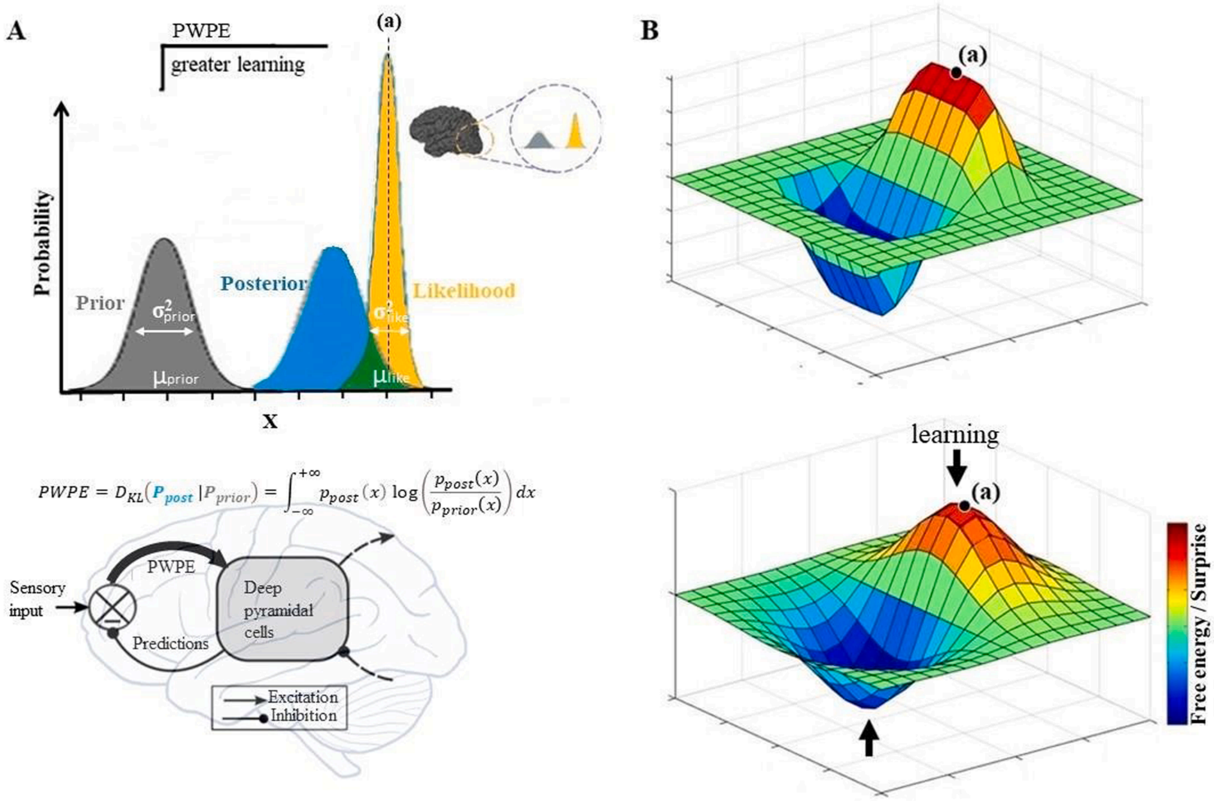

Fig. 2. Flattening of the phenomenal field. Precision weighting of priors and sensory likelihood, that inversely depend on their variance σ^2, corresponds in the FEP theory to the process of attentional allocation (Feldman & Friston, 2010). The sensory likelihood precision up-weighting (and prior precision down-weighting) allows larger magnitudes of posterior predictions updating, as depicted in panel **A**. Overall, increasing the ratio between likelihood and prior precision makes the energy landscape or phenomenal field more plastic for change. This increased plasticity is implemented via modulations of the synaptic efficacy of inhibitory and excitatory connections conveying predictions and PWPE (precision-weighted prediction errors) respectively. The bigger arrow represents larger PWPE transmission and the consequent update of higher level predictions. Because the precision (i.e. inverse variance) of prior and posterior beliefs depends on the stability/volatility of the sensory environment [187], when surprising states are observed the precision of posteriors is down weighted so that $\sigma^2_{post} < \sigma^2_{prior}$. This means that through learning surprising sensory states as (a) become less surprising as represented by the flattened phenomenal field in panel **B** of Fig. 2. At the same time homeostatic states at the basin of an attractor become less predictable. Overall, the free energy landscape changes and becomes flatter. PWPE: precision-weighted prediction error that approximates free energy in the short run.

caterpillar to a butterfly) in physical and epistemic structures and the formation of new patterns of neural activations and the corresponding "mental models" (see research on "neural packets"; [175] of action and perception [142]. A second way to reduce surprise, indeed, is perception, that is, feeling emotions and sensations. Here, instead of changing the world with an action I change my mind with sensing and learning. In this second case motor reflexes are suspended [169] while expected surprise or uncertainty needs to be temporarily tolerated and assimilated to adapt predictive representations to incoming prediction errors [176]. Our mind "eats surprise" so to speak, and grows into novel behavioural, affective and perceptual schemata. This is an allostatic process where the organism self-regulates through change.

In Fig. 1C, one can visualise the first homeostatic tension as the active sampling of sensory inputs to bring back sensory states to the nearest local minima attractor, while the second allostatic strategy corresponds to changes in the landscape of valleys and hills in the experiential field. Such strategies coexist both synchronically, when deployed across the various hierarchical levels of the generative model at any given time, and diachronically, when the two strategies alternate across time.

2.1.4. Attention as precision estimation

The complementarity of the two free-energy minimization strategies described above means the system needs a "valve" to switch from one mode to another [176,177]. That is, given the fact that attention is a limited physiological resource, the best strategy results, from time to time, in directing attentional resources either at maximizing epistemic or informational intrinsic value or at maximizing extrinsic value based on prior expectations [178,179]. We previously described the complex system of reward feedbacks, suggesting attentional modulations as potential candidates [176,180]. Such feedbacks signal the transient (informational) profitability of directing neural (i.e. attentional) resources to changing predictive representations via perceptual learning rather than acting based on previous routines [176,181]. This situation is somewhere referred to as the exploration-exploitation dilemma: "optimal integration of knowledge about the world and the goals that we are currently pursuing" ([165]; p.1).

Recent research suggested that the control of precision weighting of top-down and bottom-up transmission might underlie the attentional processing switching between the two modalities "at the surprise crossroad". In the words of Karl Friston: "If proprioceptive prediction errors can be resolved by classical reflexes or changing (proprioceptive) expectations, how does the brain adjudicate between these two options? The answer may lie in the precision afforded to proprioceptive prediction errors" ([114]; p.393). Precision weighting of PE might be a good candidate for adjusting the moment-by-moment value of surprise and the openness to change of the cognitive system [176].

Attentional processing can be understood as inferring the level of precision during hierarchical perception [182–185] and is realized via localized neuromodulatory activity. Attending to a specific stimulus or sensory stream thus means to enact and maintain an expectation of high precision for the corresponding ascending prediction error and, neurally, to increase the post-synaptic gain of the cells carrying that signal, so to become maximally receptive to the incoming sensations. In more abstract terms, this corresponds to adjusting the width of the prior and likelihood curves in *Fig. 2A*, which will result in different magnitudes of perceptual learning (distance between prior and posterior distributions). Whenever the ratio of the precision assigned to predictions and bottom-up sensory signals (represented as the width of the prior and likelihood distribution in *Fig. 2A*) favours the latter learning is increased, that is, the generative model is updated by larger prediction errors and the free energy landscape (i.e. phenomenal field) changes (*Fig. 2*). When incoming novel sensations are up-weighted, or else priors are down-weighted, or both, they force the system to update generative models of "what is happening to me". Crucially, the estimates of sensory and priors' precision are not independent, but mutually influence each other. If a prior belief is held very confidently, evidence to the contrary is disregarded or ignored (i.e. sensory precision is down-weighted) or actively cancelled with action (for a detailed discussion on how precise prediction drive action and motivation see [154]). In such cases, attention and consciousness remain anchored to prior predictions. On the contrary, unprecise priors are rapidly updated and sensory likelihoods dominates inference. That is, precise prior beliefs lead to a compensatory decrease in the precision of the likelihood distribution and vice versa [186].

2.1.5. Allowing for surprise: attentional modulations at the crossroad

By transitorily allowing for surprise/entropy to enter the system attentional modulations trigger allostasis. This is a central point in our discussion since modulating attention might be what therapists learn to do with their practice and experience. Indeed, as we discuss more in detail in § *Epistemic trust at the edge of criticality*, by allowing for surprise to emerge in a phenomenal field, therapists might encourage the self-organization of the patient-therapist-environment system into novel dissipative structures. Interestingly this intuition is common to most recent neurocomputational accounts of psychotherapeutic change, independently from their orientation [188]. Taking psychoanalysis as an example, as noted by Rabeyron et al., ([56]; p.1): "psychoanalytic therapies imply non-linear processes taking time to unfold and require a setting containing high entropy processes. More precisely, these processes are characterized by an interplay between extension and reduction of free energy. This interplay also favours the emergence of new orders of subjective experience, which occur following states of disorder, according to a certain energetic threshold allowing the modification and improvement of mental functioning. These high entropy states are also characterized by random functioning and psychic malleability which favours the exploration of subjective experience in an original manner". More precisely, it might be the down-weighting of priors' precision that allows for transient states of "extension of free-energy", as recently suggested by Patrick Connolly [132]: "the increase in the instability of a client's functioning due to therapy can be conceptualized as a reduction in the precisions (certainty) with which the client's prior beliefs about themselves and their world, are held […] which allows the client to 'open up': to experience thoughts, emotions and experiences they did not have before". Similarly, from a field-based perspective, we hypothesize that shared priors' precision down-weighting depends on the therapist's attentional attitude, that can promote instability, or better say "metastability" (see §3.2), in the patient-therapist-environment system. By modulating attention, the therapist can change the ratio between the precision of shared priors and sensory likelihood, this "heats up" the shared phenomenal field (Surprise/PWPE enter the system) which "melts" and flattens like in *Fig. 2b*. Indeed, according to predictive coding schemes encountering surprising events is sufficient for flattening prior expectations. That is, surprising events make us believe our sensory environment is more uncertain (i.e. the stability of our environment and the degree to which the present resembles the past) and we down-weight the precision of prior beliefs accordingly, like in Fihure2a so that $\sigma^2_{post} < \sigma^2_{prior}$ [187].

2.2. Synergetics

2.2.1. Science of cooperation

A second model for describing the process of assimilation of novelty that might underlie psychotherapeutic change is synergetics [189]. Synergetics, etymologically the "science of cooperation", is a theory of complex systems originally developed by Haken [189]. It aims at describing in mathematical terms the unifying principles of self-organization in open complex systems. Not restricted to a specific ontology, synergetics has been widely applied to biological morphogenesis and importantly for our aim to psychopathology and human change [8,9,14,190–196]. Synergetics was applied to systems in domains such as cognition, Gestalt perception and brain dynamics [197,198] and psychotherapy [8,199]. Pattern formation processes can be observed not only in physical complex systems such as the brain [200], but in subjective mental experience as well [201]. Gestalt perception has been widely suggested as an example of such subjective epistemic structures in the mental domain [198]. The dynamics of open systems are circularly causal processes by which the parts, by means of self-organization, give rise to the global structure of a system. The latter can be mathematically described by an order parameter (OP). A central property of such systems is that their order emerges spontaneously, that is, by means of self-organization (bottom-up), just as the tendency of living systems to revisit more probable states thereby determining their structure and econiche due to free energy minimization. The interaction between the parts of the system gives rise to an OP that then prescribes (top-down) the behaviour of the parts, a process termed the slaving principle, in circular causality (Fig. 3). In the case of the human organism or systems of human organisms, what are control parameters and order parameters? Gestaltists call these attractor states or OPs Gestalts, wholes that determine the parts. Generally, one may equate OPs with patterns of feeling, thinking and behaving, such as emotions, cognitive schemata, perceptual Gestalts, and goal-directed actions.

Spontaneous pattern formation demands that the system is open and, in physical systems, situated far from thermal equilibrium, or, in mental systems, involving motivational tensions. Some energy exchange must be possible, e.g., planet earth is an open system heated by the sun. This means that open systems have an environment that provides gradients of energy or, in mental, epistemic and social systems, semantic information, affects, affordances, or motivation [8]. These gradients are referred to as control parameters, which constantly drive the system away from equilibrium. There is no such thing as a perfect resting state (see § *Suffering as wandering dynamics* for a further discussion) until death. The potential or control parameter for single minds or for a system of sensorily coupled minds can be understood as an emotional tension, excitement/arousal or dissonance to be reduced.

To trace a parallel with the FEP, it is possible to understand free-energy gradients as control parameters for the mind: "These parameters are commonly energy gradients in physical systems, and in the application of synergetics to mental and information processing systems, they have the shape of motivational forces and affordances. In the terminology of the free-energy principle, free-

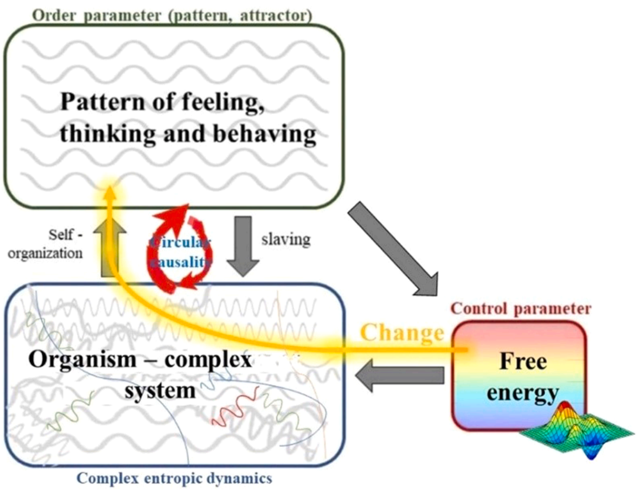

Fig. 3. Self-organization and slaving in psychotherapy. Synergetics can be applied to the organism-environment interaction. In this case the control parameter might be described in terms of incoming Bayesian surprise (i.e. PWPE) approximating free energy, phenomenologically felt as salient arousing dissonance [152,202] or emotional tension [203]. This parameter feeds the complex dynamics that characterize the organism-environment interaction. The complex dynamics of self-organizing systems, here symbolized by disordered wave lines, are synchronized, and coordinated by structural elements, the order parameters. These patterns can be disturbed and globally altered by critically increasing energetic tensions, when emotional tension (control parameter) reaches a critical level. Then, entropic dynamics are enslaved and synchronized to an attractor state, which in the case of human organisms or systems of human organisms, might be a pattern of feeling, thinking and behaving.

energy minimization is the equivalent of a system relaxing to a potential minimum (K. Friston, private communication), and free energy acts as a control parameter for the mind" ([201]; p.8). As an example, in the pathological self-organization into delusional attractors: "critical emotional tension, which usually precede the outbreak of psychosis, may represent a clinical manifestation of increased free energy (i.e., ego-dystonic unpredictability and uncertainty)" ([190]; p.7). Free-energy increases trigger a new cycle of self-organization, either in the direction of healing or pathology [6]. The Synergetics model has seen an interesting extension when the retrograde effect of pattern formation on the driving free energy (the control parameters in the terminology of synergetics) was considered in detail. The result of pattern formation is a reduction or depletion of the control parameters [204,205]. Here we see another loop at work: Self-organized patterns feedback on the control parameters that have instigated self-organization in the first place. It was even found that the more ordered the emerging patterns, the higher their capacity to deplete the control parameters. Those patterns are selected by the complex system that are best able to consume the free energy expressed by the control parameters.

Every attractor state or order parameter is characterized by a valence representing the attraction or salience of this pattern for the individual person [206,207]. Different attractors (i.e. patterns of feeling thinking and behaving) compete and the one with the highest motivational valence wins; the larger the valence, the faster the attractor of the pattern will be reached [207]. Valence of different states depends on the potential function which gives a potential value to all possible states. At high potential values, change is likely, while at minimum potential values the system resides in a stable state (i.e., in an attractor). The stability of states can be represented by valleys and hills in the "landscape" of such a state-space (see *Fig. 1D*). As system states tend to relax toward states conveying lower free-energy, the momentary state of a system follows trajectories defined by potential functions. A common example in physics is the gravitational potential, which provides a measure of the (free) energy available for movement at any state within a potential landscape. The gravitational potential is high at the peaks of the landscape, but low at the bottom of a valley, where the system consequently comes to a rest (as in *Fig. 1* and *2*). Similarly, in a mental system, variational free-energy gradients define the potential landscape and determine the trajectory of self-environment states [9,23]. The valleys, with lower free energy, therefore, represent attractors: the probability of the system to be in state x follows a probability distribution p, where p(x) is negatively related to the potential function V(x). That is, the potential of a state determines the force of attraction toward itself, as in the tradition of Lewin's (1951) psychological field theory. A "field" is filled with a constellation of psychological forces (Lewin also used the terms "vectors", "affordances" or "valences"; [208] that determine the behaviour of an individual in an environment. Just as temperature gradients power a far-from-equilibrium physical system, by providing a field of "affordances" the environment "serves both as the motor behind an individual's behaviour and as the arena for an individual's motivational tensions" ([204]; p.9). Tschacher and Haken ([9]), similarly to our approach, equate field with a state space, which allows to explore the forces in the field using a potential landscape. The potential function is then linked to the overall motivational tension contained in life space, with low potential (i.e. minimized free energy) denoting motivational satisfaction.

2.2.2. Psychotherapy in the circular causality loop

Tschacher and Haken [8] have applied the synergetic model to psychotherapy process, using the Fokker-Planck equation that describes the change of probability of a state as a combination of deterministic and stochastic processes: Change = Causation + Chance. Aprioristic causal mechanisms create attractors, whereas random (we would rather say surprising) inputs destroy attractors and increase entropy. As we have seen above, self-organizational dynamics also have the deterministic effect of creation of attractors, or of changing a pre-existing attractor landscape. Applying the Fokker-Planck model to psychotherapy process, a taxonomy of intervention can be derived. Deterministic interventions are those that move the location of attractors (e.g. by behavioural learning and unlearning techniques). Stochastic interventions, similarly to what we are here describing, regulate the boundary of the system to either ward off or invite surprising inputs; surprising inputs have the power to destruct existing attractors (e.g. weakening a depression pattern by activating a patient and allowing novel experiences).

Change can be gradual, with slow minor adjustments shifting away from the dominant pattern, or else abrupt when the control parameter that influences the system reaches a critical point the dominant attractor state can suddenly reorganize [209,210] after periods of turbulence, as attractors destabilize and trigger order transitions, such as the switch from a healthy state to a diseased state or vice-versa [211,212]. For successful therapy, the emergence of novel experience patterns whose valences are larger than the pathological valence is necessary [207]. This means that the potential landscape (in synergetics terms), else defined as field forces (in Lewinian terms) or the free energy gradient landscape (in FEP terms), needs to change for novel attractors to dominate experience. As we discussed previously, what changes is the potential landscape that becomes shared as soon as the therapist and the client become sensorily and affectively coupled. The "therapeutic alliance state-space" is be created "by merging two individual phase spaces (the therapist's and the patient's, x1 and x2) and a potential value V(x1, x2)" ([23]; p.10) which is then modified by the therapeutic experience.

Coherently, our hypothesis is that psychotherapy allows the patient-therapist organism to accept a transient rise in free energy by attending surprising inputs or PE (i.e. down-weighting priors and up-weighting sensory likelihood). That is, as in the stochastic intervention described above, surprising information that diverge from the Order Parameter gain momentum and force the system to self-organize into a novel attractor or pattern. Finally, the free energy landscape of valleys and hills changes and flattens.

3. Healing field dynamics

3.1. 3.1 shared models and slaving forces in the therapeutic field

Field based psychotherapy suggests that therapist's and client's experience are emerging from the field forces in play [46]; these forces are the intrinsic tensions of the emerging field. Understanding the therapeutic process of change as a field phenomenon means that it is made by the forces already active in the field. It is the psychopathological field itself that contains the potential for change [44]. As we discussed above, field forces are determined by a free energy potential function V(x), but what are the dynamics that allow the therapist to be taken by pathological (and potentially transformative) field forces?

According to the slaving principle of synergetics [189], slowly varying systems achieve control over systems varying more quickly [23]. Similarly, as it was shown by Friston and Frith [114], when two agents start from different generative models, they influence each other through diachronic inference (Friston et al., 2020) and mingle into a generalized synchronization manifold [114,213,214]. The rate at which each member converge upon the shared generative model is dictated by the precision assigned to their prior beliefs [114,122,132]. The agent with the higher precision placed in her model of the world has more influences on the other. The phenomenal landscape with the stronger attractors (deeper valleys) prevails in the negotiation that leads to a shared landscape [23]. This is crucial for our aims, since we suggest that the therapist momentarily down-weights the precision assigned to their prior beliefs. In principle, this skill would allow the therapist to quickly converge on a shared pathological phenomenal landscape. At the initial step of the therapeutic encounter, the therapist "gets sick" like the client. The pathological pattern of feeling, thinking and behaving enslaves the therapist whose experience is attracted within rigid homeostatic boundaries. The therapist begins therapy by moving and feeling according to the experiential landscape where they meet the client, like feeling no sincere involvement and a sense of stickiness in the first clinical example (*Table 1*) or else feeling heavy or distant in a depressed field. The field of forces is structured so that some experiences are possible other are probable and other impossible. Psychoanalysts describe this in terms of "affect phobia". That is, some feelings that lay far from stable attractor states in the dyadic relational field are blocked and inhibited while anxiety rises, this blockage can be enacted in therapy which focuses on the experience/expression of avoided feelings [215]. Free energy minimization gradients attract experiences toward less disturbing "basins of attraction" and shape "unconscious models that influence current behaviour" ([83]; p.489). This means that humans are able to gate experience when the level of psychic entropy would be overwhelming (consider peritraumatic dissociation as a classical example). We previously suggested that unprocessed experiences (somewhere referred to as "non-represented bits of experience"; [216]) do not simply disappear, but remain encapsulated or inscribed in the experiential possibilities of a given field [6,84] as "sensorial footprints" [110]. Such "hot" states are associated to higher free energy. This results in the dissociation between anesthetised affective states (visceral reactions and motor activation) and the full conscious experience of an emotion [84]. Unprocessed hot states are potentially the most transformative ones since they could provide higher free energy to the system. However, in psychopathology habitudinal behaviour, mood, and personality becomes structured around the avoidance of such experiences [84,217].

Synergetics and the FEP can account for such "deterministic forces" ([8]; p.1082) that correspond to the existence of a probabilistic attractor function (the inverse of a potential function) that determines the complex system to move toward a certain more probable state or patten that are best capable of reducing their environmental free energy gradients. The focus on field forces [9] and "free energy landscapes" [175,218,219] fits with the phenomenological intuitions of field based psychotherapy which states that the same field force can result in conservation or transformation, depending on the therapist's modulation of her presence (i.e. embodied attention; [20,84,112]). In FEP terms, deterministic conservative forces push agents in the field to reconduct constantly emerging prediction errors within homeostatic boundaries. Conservative forces, however, can become transformative as soon as (precision-weighted) prediction errors are allowed to transform the shared generative model [56]. Free energy gradients can either power the active sampling of sensory states (e.g. acting-out, dissociation or anesthesia) or change the shape of the environmental gradients and attractor states. Consider the first clinical example in Table 1. Attractor states are here represented by the lack of sincere involvement, the perception of working in an auto-pilot mode, the sense of duty to try harder. After a few sessions some "proto--feelings" conveying higher and distressing sensory surprise start to emerge from the phenomenal field: the therapist picks up a sense of stickiness and dirt surrounding the patient. She does a lot of things to avoid these disturbing sensations and to avoid touching the patient (e.g., wiping the couch or other active samplings of sensory states in the environment). Meanwhile, she also feels curious about these uncanny sensations. We might speculate that at that stage the therapist feels the tension between two opposing forces desiring and avoiding sensory surprise. However, as soon as she tolerates surprising sensory states, what was unprocessed and remained in the phenomenal field as a sensorial footprint now emerges as a full-fledged emotion: disgust, which was not legitimate in this phenomenal field. The field now melts and change like in *Fig. 2B*. Disgust now becomes more probable in the horizon of all possible experience and informs future behaviour while the previous pathological attractor state becomes less probable.

3.2. Metastability and the paradoxical search for surprise

3.2.1. Suffering as wandering dynamics

How can this intuition of a paradoxical search for entropy/surprise be applied to psychotherapy? This intimately linked to the "meaning" of psychological suffering. Previous studies have described psychopathology as the emergence of Dysfunctional Attractor states [8,9,207]: "A client's being stuck in a recurrent condition is represented by an attractor in a dysfunctional or psychopathological region of the client's state space. When the goal of therapy is to alleviate symptoms, the interventions must be capable of destabilizing the respective symptom attractor, or establishing a novel attractor in a different, healthier region of state space. When therapy deals with a client's symptomatic relapse or fear of relapse, we have likely encountered multistability: In other words, there are multiple attractors, and one of these is located in the symptomatic region" ([9]; p.13). However, the recurrence of a symptomatic pattern alone does not necessarily explain subjective suffering. Psychopathological patterns as any attractor state are characterized by a stable state associated to lower Free Energy. If, as we assumed, emotional valence positively marks less surprising states [203], according to the general free energy minimization imperative, we would expect humans to live quite happily even in psychopathology. Why do we suffer then? Why don't we simply stay happily in the attractor psychopathological basin and feel the urge to change?

There might be a number of reasons, most importantly for our aims, agents actively and paradoxically seek entropy. They actively try to get out of the attractor basin by actively seeking prediction errors (i.e. surprising states) for the seek of learning. Moving from an attractor state to another, however, requires experiencing transient rises of entropy associated to sensory states. When the system is provided with the necessary support it is able to tolerate transient rises in entropy and acts on the base of wondering and peripatetic dynamics. It is pushed to explore entropic states since this is profitable for the long-run minimization of free energy. Suffering is in this sense part of the healing process.

This is what it means to suffer, an intentional (but not necessarily voluntary) transitory rise in entropy for the seek of a future and unknown less entropic pattern of feeling thinking and behaving. Suffering literally means to bear (from latin *fero*, to bear) and patients bear unprocessed experiences that can potentially be felt, recognised and transformed [82]. Suffering, therefore, takes shape depending on the potentiality for transformation that the situation offers [46]. This corresponds to the field therapy intuition that some arousing and distressing sensory/affective and relational states that are usually unlikely in a given field might push to emerge in therapy [20], so that at the end, what is usually less likely to happen in given phenomenal field is exactly what is most likely to happen in the therapy room. All what therapists can do is to support and sustain this self-heling intentionality of the patient-therapist couple.

3.2.2. *Errare humanum est: the anarchy of metastable attunement*

The word error etymologically means to move. Perhaps this reflects the necessity of encountering some prediction errors on our way to evolve and grow [6,67,81,176,181,220]. Indeed, "in a changing environment, the effective long-term minimization of the average prediction error does not proscribe, in fact prescribes, transient excursions into surprise-rich ventures: the latter equip the system with an enhanced capacity to face unexpected mutations of its environmental niche, underwriting the crucial role of sporadic novelty-seeking behaviour" [221]; p.3). In simple term, we are not happy when we encounter no surprise at all, as in a dark room (see the "dark room paradox" in [67]) on the contrary, we are happy when we are able to maintain a positive rate of surprise reduction. We actively seek sensory environments with a certain degree of expected surprise [68], just as patients actively look for a therapy room. Lively organisms, indeed, strive to live in a world with some surprise [80,222] and seek to resolve it [163,223]. Experience, if is not traumatic, teaches us to expect, to encounter, and "explain away" prediction errors [224,225], to maintain a certain "innovation rate" through exploration [226]. McReynolds [226] identified the minimisation of "unassimilated perceptual material" as the drive of such intrinsic motivation. In terms of predictive coding, since birth we build expectations over the (positive) rate of PE reduction based on our experienced ability to reduce them [79–81]. Through various experiences of being able to reduce PE in a shared intercorporeal and interaffective space we learn to expect and tolerate certain non-zero rates of change in prediction errors, which makes us inclined to feel, sense, explore and learn [225]. We paradoxically expect surprise [227], as much as we expect we can handle, because it supports the progressive learning of higher-order regularities in the sensory world, leading to more refined representations of the environment [225].

We can see this also in the terms of metastability, in order to change an attractor state, we must accept a transitory rise in entropy for the seek of an attractor state that we don't know yet how it is like, but we know is there (Fig. 4). This is the paradoxical search for surprise. That is, beyond homeostasis, "autopoietic and self-regulating systems, also have a tendency to actively destroy attractor states, thereby inducing instabilities and creating peripatetic or itinerant (wandering) dynamics" ([72]; p.13; see also [75,204,228]. Organisms and systems of organism do so at multiple scales, from social norms down to brain networks inside the skull: "metastability (with its slow-fast, dwellescape dynamic) is the way the brain constantly creates and destroys neural assemblies [...] Metastability

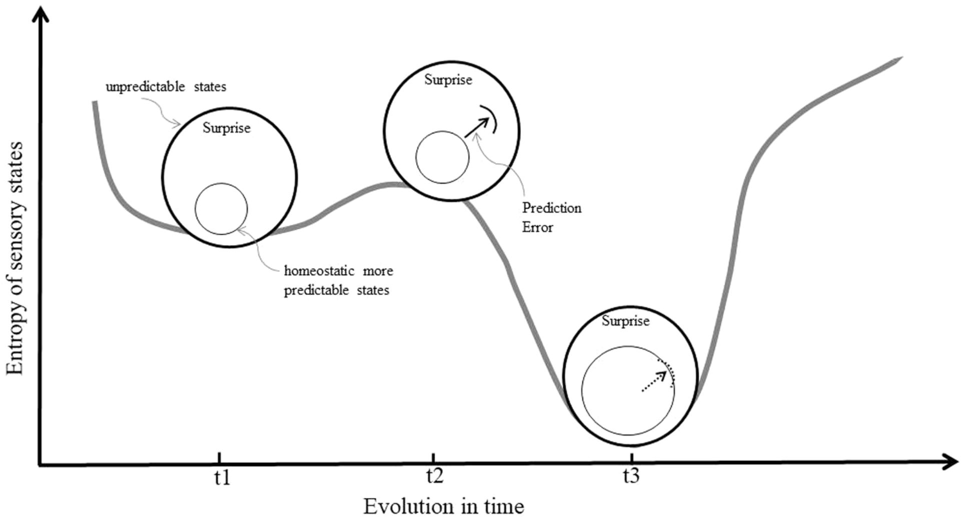

Fig. 4. Metastability. Transient rises in surprise must be paradoxically tolerated to reach a lower less dysfunctional local minimum. At t2, when a prediction error is encountered, a gain in free energy verifies.

emphasizes the transient nature of the ongoing coordination dynamics and is linked to intermittency and chaotic itinerancy" ([123]; p.11). When a particular environment stops providing the expected error-reduction slopes, negative valence (i.e., psychological suffering) signals to the agents that they should destroy their usual attractors in favour of more itinerant wandering policies of exploration [72]. Alternatively, when errors accumulate, due to frequenting niches where there is an unmanageable uncertainty, the negative valence then forces the agent to fall back on opportunities for action, perceptions and feelings that are already well known. When all goes well, such slope-chasing healthy agents will be constantly informed by changes in error-reduction dynamics and moved towards this edge of criticality, where encountered states are neither to complex nor too easily predicted that the agent no longer has anything to learn [79,229]. Therapists often find themselves on this edge of criticality, as in the first clinical example in *Table 1*, where the therapist is concomitantly interested and disturbed by uncanny sensations (the sticky sensations in the example), while she/he feels the ambiguous urge to explore and avoid it. Being attuned in this way to the edge of criticality makes for a healthy agent that maintains an optimal balance between efficiency and degeneracy [230] and remains open to exploring a wide variety of other possible contexts to bring about their goals [231].

However, the projection toward growth and novelty, and exploratory behaviours seems sometimes to fade away in pathological conditions. Psychopathology might be characterized by the loss of this ability to change and tolerate transient rise in free-energy at the edge of criticality. When the value of uncertainty (i.e. expected surprise) is underestimated, presumably because of previous unfortunate attempts to reduce surprise, the avoidance of surprising states prevents allostatic change. In neurocomputational terms, psychopathological systems expect a lower learning rate [6,232], they do not expect (i.e. desire) to be surprised. Psychopathology might be a particularly rigid case of surprise avoidance and a radicalization of the homeostatic drive [233]. On the contrary, healthy organisms and system of organisms can be defined as relationally flexible, that is they have the capacity to pass from one stable state to another independently from the anxiety lying within them [234]

As an example, it has been suggested that Major Depression is a "better safe than sorry" adaptive responses to adverse social events. Such strategy minimises the likelihood of the occurrence of surprising interpersonal interactions (like social exclusion; [235]). This behaviour might follow ineffectual attempts to alleviate interpersonal difficulties (e.g., social uncertainty; loss) In solitude or in competitive or adverse social contexts [235], the patient learned that it is not possible to reduce uncertainty (i.e., prediction errors) through action policies and learning [236]. The organism learns that it cannot reduce social distance in its social context (learned helplessness; [237]. Since surprise cannot be reduced [238] uncertainty is negatively valenced [147,239] and thus avoided. In the case of depression, surprise is avoided by down-weighting the affective/interoceptive prediction errors (i.e. pain and sadness) that signal social exclusion and loneliness. This finally results in emotional numbess. Indeed, interoceptive awareness [240–244] and interoceptive cortex activation atypicalities were observed in depression [245–247], these being generally interpreted as the consequences of the attempt to reduce negative affect (pain and sadness in our second clinical example in Table 1) by reducing attention toward internal signals associated with negatively valenced emotions [248]. In such cases, recovery in psychotherapy, as suggested in the second clinical example, might be triggered by "relearning" through the therapeutic relationship a positive expected rate of error reduction through experience and engagement with the world [72]. The expectation of being able to reduce PE in the long run allows to transiently tolerate them and feel pain and sadness signalling loneliness: the "emerging absence" that inaugurates the healing grief process [249].

3.2.3. *Epistemic trust at the edge of criticality*

Humans need to trust that they will eventually reduce surprise to tolerate it. This sort of "epistemic trust" [250] can be defined as the appraisal of incoming relational information as personally relevant, accurate and reliable, thereby allowing for the information (i.e., PWPE) to be incorporated into existing relational models [251,252]. Epistemic trust has been proposed to be: i) generally impaired in psychopathology [253]; ii) a key treatment target in psychotherapy [250,253,254]. Coherently, we suggest that the therapeutic function might be to restore the belief that surprise can be reduced over time and that we can learn from it by updating our internal predictive representations, thereby reducing average free energy in the long run. In this way the system of organisms that is composed by the therapist and the patient can tolerate a transient rise in sensory surprise. They can "suffer together". Computationally this is equal to restoring a positive value of uncertainty (i.e., expected surprise). [Gestalt therapist call this strive for uncertainty "cultivated uncertainty" or "willingness to be uncertain" and consider it essential for change [53,255,256]].

Similarly, psychoanalysts [56], highlighted the importance of a "disposition of mind" reminiscent of Bion's "negative capability" which enables free energy tolerance and allows a "top-down reset" [133,257]. The therapeutic disposition of mind "promotes the increase of emotional and primary processes (which increase free energy) and the decrease of cognitive and secondary processes (which reduce free energy) […] which allows the patient and the clinician to be surprised by what emerges in the analytical setting […] emotions and affects are also catalyzed in this psychic state and correspond to an increase of bottom-up processes. In this sense, the setting and a certain 'disposition of mind' favors entropic functioning and a form of disorganization of the usual psychological activity during psychotherapy" ([56]; p.4). When the patient-therapist couple becomes capable of assimilating PE it is more in contact with the body and with the environment, and thus updates and refines the generative model of "what is happening to them". This process improves the "granulosity" [258] of representations and more "nuances" [257] are available to the patient. Overall, free energy is reduced in the long-run by an enhanced ability to represent and predict the sensory environment [56,133], once dissociated proto-feelings are integrated in predictive representation of the self/environment [6].

3.3. *3.3 going off track: expected results in psychotherapy quantitative research*

The development in the processing of large longitudinal datasets evidenced the beneficial role of patterns of disorganization and reorganization of therapeutic process (e.g. therapeutic alliance) and physiological variables (e.g. hearth rate, breathing) during psychotherapy [259,260], predictive of sudden and long-term gains [261], independently from the therapist's orientation [262] and diagnosis [263]. A disorganized pattern may be characterized by the high variability of psychological (i.e. behavioural, cognitive, affective) and physiological variables, their complexity, and their low synchronization. Hence the disorganization of psychological structure and its associated benefits in terms of reorganization and novel patterns of thoughts and behaviour may be a key to understand and improve the psychotherapeutic process. Cycles of disorganization and re-integration may be interpreted as consecutive increases in the patient's internal flexibility, i.e. the alternation of old dysfunctional patterns and new and more functional patterns, followed by a reorganization into new patterns of thinking, feeling, and behaving [10,264–266]. Indeed, stabilization and destabilization of behavioural and physiological variables have been observed in the unfolding process of therapy [10,267–269] and have been shown to be positively correlated with therapeutic outcomes [9,195,267,270–272]. As we will further discuss in this section, a patient-therapist system that transiently goes "off track" [273] might achieve better therapeutic outcomes than strictly linear and deterministic therapeutic processes. According to this view, significant transformative change is preceded by the excursion in regions of the phenomenal landscape characterised by increased surprise associated to sensory states: i.e., the system "goes off track" and tolerates sensory "hot" states (e.g., the red ones in *Fig. 1C*) that reside outside the homeostatic boundary

But how is it possible to infer that the system is going "off track" by means of objective measurements? As an example, the application of complex systems theory in the field of psychopathology and the development of tools for the frequent observations of symptoms has promoted the idea that sudden transitions in symptoms may be anticipated by rising instability in the system [15,263] Similarly, the idea of self-organization and nonlinear dynamics promoted the development of new information technologies such as the Synergetic Navigation System based on daily ratings of the therapeutic process [18,274,275] which is already guiding psychotherapists and patients to jointly decide how to support the dynamics that the system is creating by itself. Furthermore, sudden gains research in psychotherapy has generally demonstrated that patterns of disorganization and reorganization of process variables (as measured by the 7 factor Therapy Process questionnaire rating "well-being and positive emotions", "relationship with fellow patients", "therapeutic alliance and clinical setting", "emotional and problem intensity", "insight/confidence/therapeutic progress", "motivation for change", and "mindfulness/self-care") can predict long-term therapeutic outcomes [261]. Alternating periods of flexibility and stability, as revealed by the analysis of the correlation matrix between process variables, is beneficial to good psychotherapeutic processes [273,276,277].

There is also evidence that transient states of entropy and disorganization at a physiological and psychological level can predict psychotherapy outcome. We already discussed the results by Tschacher and Haken [8,9] that indicate that less determinism of respiratory and hearth rate coupling was present in sessions with higher progress and better alliance. Lower determinism in relation to stochastic processes was associated with higher therapeutic alliance. Similarly, Orsucci and colleagues [278] computed informational measures of entropy and determinism of the patient and therapist galvanic responses and verbal prosody (both revealing the expression of emotions; [279]. As revealed by the authors, the patient-therapist system evolves in a dynamic relational field with oscillations, fluctuations and state transitions [51,108,280,281] between states characterized by different levels of determinism and recurrence in skin conductance and prosody. Entropy-based estimation of EEG complexity and other recent developments in the analysis of the level of determinism of neurophysiological signal are starting to be applied to the study of therapeutic change dynamics [18] and might contribute to the understanding of non-linear dynamics in psychotherapy in the future. We speculate that more entropic and less deterministic spontaneous neural activity might underlie significant change dynamics.

Furthermore, evidence from psychopharmacology might support our model. We expect to observe a correlation between transformative experiences and pharmacologically induced consciousness states characterised by the relaxation of prior expectation paralleled by the up-weighting of bottom-up surprising interoceptive sensory/affective signals (as depicted in *Fig. 2*). As suggested by the "entropic brain" account of psychedelics therapies [37,282–287]: suggesting the transition to a more entropic mode of brain functioning under serotoninergic and glutamatergic (ketamine) psychedelics which may account for their distinct phenomenology and therapeutic potential. If our hypothesis is correct, psychedelics-assisted therapy [288,289] should outperform standard psychotherapy.

4. Conclusions

In the present work, we reviewed biophysical models of psychotherapeutic change based on synergetics and the free energy principle. On the base of previous contributions, we suggest that stochastic and contextual intervention might achieve change in a way that cannot be predetermined, by allowing free energy to enter the patient/therapist superindividual system. In sum, throughout the paper we suggest that the intentional modulation of the therapist's energy/information exchange can help the sensorily coupled therapist-patient organization to tolerate transient states of increased entropy associated to unpredicted sensory states, at the same time promoting the allostatic morphogenesis of their homeostatic boundary. As previously discussed [132], in FEP terms, this might happen through the weakening of the estimated reliability associated with priors predictions and the parallel up-weighting of the relevance of novel surprising sensory states. In the long-run, such paradoxical exploration of surprising states can trigger self-reorganization processes. Metaphorically, surprising "hot" states can "melt" the phenomenal landscapes that provides free energy gradients. Thanks to this transient state of plasticity, the latter reorganizes into a landscape with novel attractor states. Therapy might be considered as a peripatetic wandering dynamic that follows transformative intentionalities that belong to field.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

I.R. is funded by PON project 'Ricerca e Innovazione' 2014–2020 (Italian Ministry of University and Research).

References

[1] Young C. Twenty different definitions of European psychotherapy. Int J Psychother 2011;15:23.
[2] Cuijpers P, Reijnders M, Huibers MJH. The role of common factors in psychotherapy outcomes. Annu Rev Clin Psychol 2019;15:207–31.
[3] Tschacher W, Meier D. Physiological synchrony in psychotherapy sessions. Psychother Res 2020;30:558–73. https://doi.org/10.1080/10503307.2019.1612114.
[4] Settanni M, Bronzini M, Carzedda G, Godino G, Manca ML, Martini L, et al. Introducing the QACP: development and preliminary validation of an instrument to measure psychotherapist's core competencies. Res Psychother 2022;25.
[5] Roubal J, Francesetti G, Gecele M. Aesthetic diagnosis in gestalt therapy. Behav Sci 2017. https://doi.org/10.3390/bs7040070.
[6] Sarasso P, Francesetti G, Roubal J, Gecele M, Ronga I, Neppi-Modona M, et al. Beauty and uncertainty as transformative factors: a free energy principle account of aesthetic diagnosis and intervention in gestalt psychotherapy. Front Hum Neurosci 2022;16:906188. https://doi.org/10.3389/fnhum.2022.906188.
[7] de Felice G, Giuliani A, Gelo OCG, Mergenthaler E, De Smet MM, Meganck R, et al. What differentiates poor- and good-outcome psychotherapy? A statistical-mechanics-inspired approach to psychotherapy research, part two: network analyses. Front Psychol 2020;11.
[8] Tschacher W, Haken H. The process of psychotherapy. Springer; 2019.
[9] Tschacher W, Haken H. Causation and chance: detection of deterministic and stochastic ingredients in psychotherapy processes. Psychother Res 2020;30:1075–87. https://doi.org/10.1080/10503307.2019.1685139.
[10] de Felice G, Giuliani A, Pincus D, Scozzari A, Berardi V, Kratzer L, et al. Stability and flexibility in psychotherapy process predict outcome. Acta Psychol (Amst) 2022;227:103604. https://doi.org/10.1016/j.actpsy.2022.103604.
[11] Heinzel S, Tominschek I, Schiepek G. Dynamic patterns in psychotherapy-discontinuous changes and critical instabilities during the treatment of obsessive compulsive disorder. Nonlinear Dyn Psychol Life Sci 2014;18:155–76.
[12] Haken H, Tschacher W. How to modify psychopathological states? Hypotheses based on complex systems theory. Nonlinear Dyn Psychol Life Sci 2017;21:19–34.
[13] Tschacher W, Haken H. Intentionality in non-equilibrium systems? The functional aspects of self-organized pattern formation. New Ideas Psychol 2007;25:1–15. https://doi.org/10.1016/j.newideapsych.2006.09.002.
[14] Tschacher W, Scheier C, Grawe K. Order and pattern formation in psychotherapy. Nonlinear Dyn Psychol Life Sci 1998;2:195–215.
[15] Hayes AM, Andrews LA. A complex systems approach to the study of change in psychotherapy. BMC Med 2020;18:197. https://doi.org/10.1186/s12916-020-01662-2.
[16] Halfon S, Cavdar A, Paoloni G, Andreassi S, Giuliani A, Orsucci FF, et al. Monitoring nonlinear dynamics of change in a single case of psychodynamic play therapy. Nonlinear Dyn Psychol Life Sci 2019;23.
[17] Halfon S, Çavdar A, Orsucci F, Schiepek GK, Andreassi S, Giuliani A, et al. The non-linear trajectory of change in play profiles of three children in psychodynamic play therapy. Front Psychol 2016;7:1494.
[18] Schiepek G. Complexity and nonlinear dynamics in psychotherapy. Eur Rev 2009;17:331–56. https://doi.org/10.1017/S1062798709000763.
[19] de Felice G, Giuliani A, Halfon S, Andreassi S, Paoloni G, Orsucci FF. The misleading Dodo Bird verdict. How much of the outcome variance is explained by common and specific factors? New Ideas Psychol 2019;54:50–5. https://doi.org/10.1016/j.newideapsych.2019.01.006.
[20] Roubal J, Francesetti G. Field theory in contemporary gestalt therapy part two: paradoxical theory of change reconsidered. Gestalt Rev 2022;26:1–33. https://doi.org/10.5325/gestaltreview.26.1.0001.
[21] Roubal J, Hytych R, Čevelíček M, Řiháček T. Personal therapeutic approach in Gestalt therapists working with clients suffering from medically unexplained psychosomatic symptoms. Res Psychother 2021:24.
[22] Tschacher W, Junghan UM, Pfammatter M. Towards a taxonomy of common factors in psychotherapy—results of an expert survey. Clin Psychol Psychother 2014;21:82–96. https://doi.org/10.1002/cpp.1822.
[23] Tschacher W, Haken H, Kyselo M. Alliance: a common factor of psychotherapy modeled by structural theory. Front Psychol 2015;6.
[24] Gorban AN, Tyukina TA, Pokidysheva LI, Smirnova EV. Dynamic and thermodynamic models of adaptation. Phys Life Rev 2021;37:17–64. https://doi.org/10.1016/j.plrev.2021.03.001.
[25] Kendall PC, Frank HE. Implementing evidence-based treatment protocols: flexibility within fidelity. Clin Psychol 2018;25:e12271.
[26] Katz M, Hilsenroth MJ, Gold JR, Moore M, Pitman SR, Levy SR, et al. Adherence, flexibility, and outcome in psychodynamic treatment of depression. J Couns Psychol 2019;66:94.
[27] Watson JC, Wiseman HE. The responsive psychotherapist: attuning to clients in the moment. American Psychological Association; 2021.
[28] Kramer U, Stiles WB. The responsiveness problem in psychotherapy: a review of proposed solutions. Clin Psychol 2015;22:277–95. https://doi.org/10.1111/cpsp.12107.
[29] Spagnuolo Lobb M, Sciacca F, Iacono Isidoro S, Di Nuovo S. The therapist’s intuition and responsiveness: what makes the difference between expert and in training gestalt psychotherapists. Eur J Investig Health Psychol Educ 2022;12:1842–51. https://doi.org/10.3390/ejihpe12120129.
[30] Aponte HJ. The soul of therapy: the therapist's use of self in the therapeutic relationship. Contemp Fam Ther 2022;44:136–43. https://doi.org/10.1007/s10591-021-09614-5.
[31] Alcaro A, Isidoro SI, Conversi D, Accoto A, Lobb MS. The emotional personality of psychotherapists: a pilot research with gestalt-therapy clinicians. Psychology 2020;11:1628.
[32] Hayes J.A., Vinca M. Therapist presence, absence, and extraordinary presence. 2017.
[33] Mergenthaler E. Resonating minds: a school-independent theoretical conception and its empirical application to psychotherapeutic processes. Psychother Res 2008;18:109–26.
[34] Fuchs T, Koch SC. Embodied affectivity: on moving and being moved. Front Psychol 2014. https://doi.org/10.3389/fpsyg.2014.00508.
[35] Bolis D, Dumas G, Schilbach L. Interpersonal attunement in social interactions: from collective psychophysiology to inter-personalized psychiatry and beyond. Philos Trans R Soc B 2023;378:20210365.
[36] Koole SL, Tschacher W. Synchrony in psychotherapy: a review and an integrative framework for the therapeutic alliance. Front Psychol 2016;7.
[37] Carhart-Harris RL, Friston KJ. REBUS and the anarchic brain: toward a unified model of the brain action of psychedelics. Pharmacol Rev 2019;71:316. https://doi.org/10.1124/pr.118.017160.
[38] Cavarra M, Falzone A, Ramaekers JG, Kuypers KPC, Mento C. Psychedelic-assisted psychotherapy—a systematic review of associated psychological interventions. Front Psychol 2022;13.
[39] Bruineberg J, Rietveld E. Self-organization, free energy minimization, and optimal grip on a field of affordances. Front Hum Neurosci 2014;8:599.
[40] Bruineberg J, Rietveld E, Parr T, van Maanen L, Friston KJ. Free-energy minimization in joint agent-environment systems: a niche construction perspective. J Theor Biol 2018;455:161–78. https://doi.org/10.1016/j.jtbi.2018.07.002.
[41] Levine HB. Stepping into the field Bion and the Post-Bionian field theory of Antonino Ferro and the Pavia group. Eur J Psychother Couns 2022;24:111–26. https://doi.org/10.1080/13642537.2022.2063358.

[42] Ferro A. Psychoanalysis and dreams: Bion, the field and the viscera of the mind. Routledge; 2019.
[43] Ferro A, Civitavese G. Psychoanalysis and the analytic fi eld. The routledge handbook of psychoanalysis in the social sciences and humanities. 1st ed. 2016. https://doi.org/10.4324/9781315650821.
[44] Francesetti G. From individual symptoms to psychopathological fields. towards a field perspective on clinical human suffering. British Gestalt J 2015;24:5–19.
[45] Francesetti G. Psychopathology, atmospheres, and clinical transformations: towards a field-based clinical practice bt - Atmosphere and aesthetics: a plural perspective. In: Griffero T, Tedeschini M, editors., Cham: Springer International Publishing; 2019, p. 223–40. https://doi.org/10.1007/978-3-030-24942-7_13.
[46] Francesetti G. The field perspective in clinical practice: towards a theory of therapeutic phronēsis. handbook for theory, research, and practice in gestalt therapy. 2nd ed. Newcastle upon Tyne, United Kingdom: Cambridge Scholars Publishing; 2019. p. 268–302.
[47] Francesetti G, Roubal J. Field theory in contemporary gestalt therapy, part 1: modulating the therapist's presence in clinical practice. Gestalt Rev 2020;24: 113–36. https://doi.org/10.5325/gestaltreview.24.2.0113.
[48] Margherita Spagnuolo Lobb. Aesthetic relational knowledge of the field: a revised concept of awareness in gestalt therapy and contemporary psychiatry. Gestalt Rev 2018. https://doi.org/10.5325/gestaltreview.22.1.0050.
[49] Mazzacane F. The Bion-Field Theory (BFT): theory, clinical tools, controversial points. Eur J Psychother Couns 2022;24:15–36. https://doi.org/10.1080/13642537.2022.2026443.
[50] Rabeyron T. Transformational processes and the analytical field: a new paradigm for models and clinical practices. L'Évolution. Psychiatrique 2020;85:e1–13. https://doi.org/10.1016/j.evopsy.2020.01.002.
[51] de Baranger M, Baranger W. La situación analítica como campo dinámico. Rev Urug Psicoanal 1961;4:3–54.
[52] de Felice G, De Vita G, Bruni A, Galimberti A, Paoloni G, Andreassi S, et al. Group, basic assumptions and complexity science. Group Anal 2018;52:3–22. https://doi.org/10.1177/0533316418791117.
[53] Staemmler F. The willingness to be uncertain. preliminary thoughts about interpretation and understanding in gestalt therapy. Int Gestalt J 2006;29:19–42.
[54] Parlett M. Contemporary gestalt therapy: field theory. editors. In: Woldt AL, Toman SM, editors. Gestalt therapy. history, theory, and practice. London: Sage; 2005.
[55] de Felice G. Dynamical Systems Research (DSR) in psychotherapy: a comprehensive review of empirical results and their clinical implications. Systems (Basel) 2024;12. https://doi.org/10.3390/systems12020054.
[56] Rabeyron T. Psychoanalytic psychotherapies and the free energy principle. Front Hum Neurosci 2022;16.
[57] Friston K. The free-energy principle: a unified brain theory? Nat Rev Neurosci 2010;11:127–38. https://doi.org/10.1038/nrn2787.
[58] Fantappiè L. Che cos' è la sintropia: principi di una teoria unitaria del mondo fisico e biologico e conferenze scelte. Di Renzo Editore; 2011.
[59] Schrodinger E. What is life?: with mind and matter and autobiographical sketches. Cambridge university press; 2012.
[60] Synergetics Haken H. Physics Bulletin 1977;28:412.
[61] Bak P, Tang C, Wiesenfeld K. Self-organized criticality: an explanation of the 1/f noise. Phys Rev Lett 1987;59:381–4. https://doi.org/10.1103/PhysRevLett.59.381.
[62] Friston KJ, Stephan KE. Free-energy and the brain. Synthese 2007;159:417–58. https://doi.org/10.1007/s11229-007-9237-y.
[63] Fields C, Glazebrook JF, Levin M. Minimal physicalism as a scale-free substrate for cognition and consciousness. Neurosci Conscious 2021;2021:niab013. https://doi.org/10.1093/nc/niab013.
[64] Northoff G, Vatansever D, Scalabrini A, Stamatakis EA. Ongoing brain activity and its role in cognition: dual versus baseline models. The Neuroscientist 2022. https://doi.org/10.1177/10738584221081752. 10738584221081752.
[65] Déli É, Peters JF, Kisvárday Z. How the brain becomes the mind: can thermodynamics explain the emergence and nature of emotions? Entropy 2022;24:1498.
[66] Friston K, Breakspear M, Deco G. Perception and self-organized instability. Front Comput Neurosci 2012;6.
[67] Friston K, Thornton C, Clark A. Free-energy minimization and the dark-room problem. Front Psychol 2012;3. https://doi.org/10.3389/fpsyg.2012.00130.
[68] McGovern HT, De Foe A, Biddell H, Leptourgos P, Corlett P, Bandara K, et al. Learned uncertainty: the free energy principle in anxiety. Front Psychol 2022;13: 943785. https://doi.org/10.3389/fpsyg.2022.943785.
[69] Henry M, Schwartz L. Entropy export as the driving force of evolution. Substantia 2019:29–56.
[70] Popovic M. Living organisms from Prigogine's perspective: an opportunity to introduce students to biological entropy balance. J Biol Educ 2018;52:294–300.
[71] Heidegger M. Zollikon seminars: protocols, conversations, letters. Northwestern University Press; 2001.
[72] Miller M, Kiverstein J, Rietveld E. The predictive dynamics of happiness and well-being. Emotion Rev 2021;14:15–30. https://doi.org/10.1177/17540739211063851.
[73] Longo G, Montévil M. From physics to biology by extending criticality and symmetry breakings: an update. Acta Europeana Systemica 2020;9:77–92. https://doi.org/10.14428/aes.v9i1.56043.
[74] Hayes AM, Yasinski C, Ben Barnes J, Bockting CLH. Network destabilization and transition in depression: new methods for studying the dynamics of therapeutic change. Clin Psychol Rev 2015;41:27–39.
[75] Maturana HR, Varela FJ. Autopoiesis and cognition: the realization of the living. Dordrecht: Springer; 1980.
[76] Dempster B. Sympoietic and autopoietic systems: a new distinction for self-organizing systems, 2000.
[77] Perls F., Hefferline G., Goodman P. Gestalt therapy. New York 1951;64:19–313.
[78] Kelso JAS. Dynamic patterns: the self-organization of brain and behavior. MIT press; 1995.
[79] Kiverstein J, Miller M, Rietveld E. The feeling of grip: novelty, error dynamics, and the predictive brain. Synthese 2019;196:2847–69. https://doi.org/10.1007/s11229-017-1583-9.
[80] Seth AK, Millidge B, Buckley CL, Tschantz A. Curious inferences: reply to sun and firestone on the dark room problem. Trends Cogn Sci 2020;24:681–3. https://doi.org/10.1016/j.tics.2020.05.011.
[81] Van de Cruys S, Friston KJ, Clark A. Controlled optimism: reply to sun and firestone on the dark room problem. Trends Cogn Sci 2020;24:680–1. https://doi.org/10.1016/j.tics.2020.05.012.
[82] Francesetti G. Pain and beauty: from the psychopathology to the aesthetics of contact. British Gestalt J 2012;21:4–18.
[83] Scharff DE, Procci WR. Chaos theoryas a new paradigm in psychoanalysis: a contribution to the discussion of models. Int J Psychoanal 2002;83:487–90. https://doi.org/10.1516/MXBK-WBVK-MENK-698K.
[84] Francesetti G, Roubal J. Field theory in contemporary gestalt therapy, part 1: modulating the therapist's presence in clinical practice. Gestalt Review 2020;24: 113–36.
[85] Merleau-Ponty M. Phenomenology of perception. London: Routledge; 2002.
[86] Roth W-M, Jornet A. Situated cognition. WIREs Cognitive Science 2013;4:463–78. https://doi.org/10.1002/wcs.1242.
[87] Dingemanse M, Liesenfeld A, Rasenberg M, Albert S, Ameka FK, Birhane A, et al. Beyond single-mindedness: a figure-ground reversal for the cognitive sciences. Cogn Sci 2023;47:e13230. https://doi.org/10.1111/cogs.13230.
[88] Tretter F, Löffler-Stastka H. Steps toward an integrative clinical systems psychology. Front Psychol 2018;9.
[89] Francesetti G, Griffero T. Psychopathology and atmospheres: neither inside nor outside. Newcastle upon Tyne, United Kingdom: Cambrige Scholar Publishing; 2019.
[90] Minkowski E. Vers une Cosmologie: fragments philosophiques [1936]. Paris: Petite Bibliothèque Payot 1999.
[91] Waldenfels B. Phenomenology of the alien: basic concepts. Northwestern University Press; 2011.
[92] Merleau-Ponty M, Smith C. Phenomenology of perception. vol. 26. London: Routledge; 1962.
[93] Damasio A. Self comes to mind: constructing the conscious brain. Random House; 2011.
[94] Limanowski J, Friston K. Seeing the dark': grounding phenomenal transparency and opacity in precision estimation for active inference. Front Psychol 2018;9: 643.
[95] Limanowski J, Blankenburg F. Minimal self-models and the free energy principle. Front Hum Neurosci 2013;7:547.

[96] Limanowski J, Sarasso P, Blankenburg F. Different responses of the right superior temporal sulcus to visual movement feedback during self-generated vs. externally generated hand movements. Eur J Neurosci 2018;47. https://doi.org/10.1111/ejn.13824.
[97] Seth A, Suzuki K, Critchley H. An interoceptive predictive coding model of conscious presence. Front Psychol 2012;2.
[98] Metzinger T. Being no one: the self-model theory of subjectivity. mit Press; 2004.
[99] Apps MAJ, Tsakiris M. The free-energy self: a predictive coding account of self-recognition. Neurosci Biobehav Rev 2014;41:85–97. https://doi.org/10.1016/j.neubiorev.2013.01.029.
[100] Allen M, Friston KJ. From cognitivism to autopoiesis: towards a computational framework for the embodied mind. Synthese 2018;195:2459–82. https://doi.org/10.1007/s11229-016-1288-5.
[101] Rudrauf D, Lutz A, Cosmelli D, Lachaux JP, LE Van Quyen M. From autopoiesis to neurophenomenology: Francisco Varela's exploration of the biophysics of being. Biol Res 2003;36:27–65. https://doi.org/10.4067/S0716-97602003000100005.
[102] Sims M. How to count biological minds: symbiosis, the free energy principle, and reciprocal multiscale integration. Synthese 2021;199:2157–79. https://doi.org/10.1007/s11229-020-02876-w.
[103] Gray J. Straw dogs: thoughts on humans and other animals. Farrar, Straus and Giroux; 2016.
[104] Agazarian Y.M. Group-as-a-whole systems theory and practice. Group (New York) 1989;13:131–54. https://doi.org/10.1007/BF01473147.
[105] Chujfi S, Meinel C. Patterns to explore cognitive preferences and potential collective intelligence empathy for processing knowledge in virtual settings. J Interact Sci 2015;3:5. https://doi.org/10.1186/s40166-015-0006-y.
[106] Smith ER, Mackie DM. Intergroup emotions. handbook of emotions. 3rd ed. New York, NY, US: The Guilford Press; 2008. p. 428–39.
[107] Woolley AW, Chabris CF, Pentland A, Hashmi N, Malone TW. Evidence for a collective intelligence factor in the performance of human groups. Science (1979) 2010;330:686–8. https://doi.org/10.1126/science.1193147.
[108] Lewin K. Field theory in social science: selected theoretical papers (Edited by Dorwin Cartwright). 1951.
[109] Lewin K. Frontiers in group dynamics: concept, method and reality in social science; social equilibria and social change. Human Relations 2016.
[110] Francesetti G, Gecele M, Roubal J. Become yourself the prey". Field perspective and emerging self in psychopathology and psychotherapy. Studi Di Estetica 2022;23.
[111] Menninghaus W, Wagner V, Hanich J, Wassiliwizky E, Kuehnast M, Jacobsen T. Towards a psychological construct of being moved. PLoS One 2015. https://doi.org/10.1371/journal.pone.0128451.
[112] Francesetti G. Fundamentals of phenomenological-gestalt psychopathology: a light introduction. Bordeaux: L'Exprimerie; 2021.
[113] Bolis D, Schilbach L. Beyond one Bayesian brain: modeling intra-and inter-personal processes during social interaction: commentary on "mentalizing homeostasis: the social origins of interoceptive inference" by Fotopoulou & Tsakiris. Neuropsychoanalysis 2017;19:35–8. https://doi.org/10.1080/15294145.2017.1295215.
[114] Friston K, Frith C. A duet for one. Conscious Cogn 2015;36:390–405. https://doi.org/10.1016/j.concog.2014.12.003.
[115] Hunt T, Schooler JW. The easy part of the hard problem: a resonance theory of consciousness. Front Hum Neurosci 2019;13.
[116] Young A, Robbins I, Shelat S. From micro to macro: the combination of consciousness. Front Psychol 2022;13.
[117] Tomasello M, Carpenter M, Call J, Behne T, Moll H. Understanding and sharing intentions: the origins of cultural cognition. Behav Brain Sci 2005;28:675–735. https://doi.org/10.1017/S0140525X05000129.
[118] Vasil J, Badcock PB, Constant A, Friston K, Ramstead MJD. A world unto itself: human communication as active inference. Front Psychol 2020;11.
[119] Rizzolatti G, Craighero L. The mirror-neuron system. Annu Rev Neurosci 2004;27:169–92. https://doi.org/10.1146/annurev.neuro.27.070203.144230.
[120] Friston K. Life as we know it. J R Soc Interface 2013;10:20130475. https://doi.org/10.1098/rsif.2013.0475.
[121] Kilner JM, Friston KJ, Frith CD. The mirror-neuron system: a Bayesian perspective. Neuroreport 2007;18.
[122] Friston KJ, Frith CD. Active inference, communication and hermeneutics. Cortex 2015;68:129–43. https://doi.org/10.1016/j.cortex.2015.03.025.
[123] Kelso JAS, Dumas G, Tognoli E. Outline of a general theory of behavior and brain coordination. Neural Netw 2013;37:120–31. https://doi.org/10.1016/j.neunet.2012.09.003.
[124] Veissière SPL, Constant A, Ramstead MJD, Friston KJ, Kirmayer LJ. Thinking through other minds: a variational approach to cognition and culture. Behav Brain Sci 2020;43:e90. https://doi.org/10.1017/S0140525X19001213.
[125] Palacios ER, Razi A, Parr T, Kirchhoff M, Friston K. On Markov blankets and hierarchical self-organisation. J Theor Biol 2020;486:110089. https://doi.org/10.1016/j.jtbi.2019.110089.
[126] Friston K, Levin M, Sengupta B, Pezzulo G. Knowing one's place: a free-energy approach to pattern regulation. J R Soc Interface 2015;12:20141383. https://doi.org/10.1098/rsif.2014.1383.
[127] Kirchhoff MD. Autopoiesis, free energy, and the life–mind continuity thesis. Synthese 2018;195:2519–40. https://doi.org/10.1007/s11229-016-1100-6.
[128] Ramstead MJD, Kirchhoff MD, Constant A, Friston KJ. Multiscale integration: beyond internalism and externalism. Synthese 2021;198:41–70. https://doi.org/10.1007/s11229-019-02115-x.
[129] Tison R, Poirier P. Communication as socially extended active inference: an ecological approach to communicative behavior. Ecol Psychol 2021;33:197–235. https://doi.org/10.1080/10407413.2021.1965480.
[130] Krueger J. Extended cognition and the space of social interaction. Conscious Cogn 2011;20:643–57. https://doi.org/10.1016/j.concog.2010.09.022.
[131] Rietveld E, Kiverstein J. A rich landscape of affordances. Ecol Psychol 2014;26:325–52. https://doi.org/10.1080/10407413.2014.958035.
[132] Connolly P. Instability and uncertainty are critical for psychotherapy: how the therapeutic alliance opens us up. Front Psychol 2022;12.
[133] Holmes J. The brain has a mind of its own: attachment, neurobiology, and the new science of psychotherapy. Confer Limited; 2020.
[134] Varela FJ. Neurophenomenology: a methodological remedy for the hard problem. J Consciousness Stud 1996;3.
[135] Heidegger M, Stambaugh J, Schmidt DJ. Being and time. State University of New York Press; 2010.
[136] Guidano VF. The self in process: toward a post-rationalist cognitive therapy. New York, NY, US: The Guilford Press; 1991.
[137] Mahoney MJ. Human change processes: the scientific foundations of psychotherapy. New York, NY, US: Basic Books; 1991.
[138] Varela FJ, Thompson E, Rosch E. The embodied mind: cognitive science and human experience. MIT Press; 2017.
[139] Hinton GE, Van Camp D. Keeping the neural networks simple by minimizing the description length of the weights. In: Proceedings of the sixth annual conference on Computational learning theory; 1993. p. 5–13.
[140] Friston K, Kilner J, Harrison L. A free energy principle for the brain. J Physiol Paris 2006;100:70–87. https://doi.org/10.1016/j.jphysparis.2006.10.001.
[141] Ramstead MJD, Badcock PB, Friston KJ. Answering Schrödinger's question: a free-energy formulation. Phys Life Rev 2018;24:1–16. https://doi.org/10.1016/j.plrev.2017.09.001.
[142] Haken H, Portugali J. Information and self-organization ii: steady state and phase transition. Entropy 2021;23. https://doi.org/10.3390/e23060707.
[143] Yontef G, Jacobs L. Gestalt therapy. Current Psychother. 7th Ed. Instr; 2005. p. 299–336. https://doi.org/10.1177/009318530403200411.
[144] de Felice G., Verde P.C., Giuliani A., Nabokov V. Osservazione, Ascolto e Interpretazione. Elementi dell'incontro con il paziente 2020.
[145] Friston K. Learning and inference in the brain. Neural Netw 2003;16:1325–52. https://doi.org/10.1016/j.neunet.2003.06.005.
[146] Friston K, FitzGerald T, Rigoli F, Schwartenbeck P, O'Doherty J, Pezzulo G. Active inference and learning. Neurosci Biobehav Rev 2016. https://doi.org/10.1016/j.neubiorev.2016.06.022.
[147] Barrett LF, Quigley KS, Hamilton P. An active inference theory of allostasis and interoception in depression. Philos Trans R Soc B 2016;371:20160011. https://doi.org/10.1098/rstb.2016.0011.
[148] Barrett LF, Simmons WK. Interoceptive predictions in the brain. Nat Rev Neurosci 2015;16:419–29. https://doi.org/10.1038/nrn3950.
[149] Barrett LF. The theory of constructed emotion: an active inference account of interoception and categorization. Soc Cogn Affect Neurosci 2017;12:1–23. https://doi.org/10.1093/scan/nsw154.
[150] Palacios ER, Razi A, Parr T, Kirchhoff M, Friston K. On Markov blankets and hierarchical self-organisation. J Theor Biol 2020;486:110089. https://doi.org/10.1016/j.jtbi.2019.110089.

[151] Seth AK, Friston KJ. Active interoceptive inference and the emotional brain. Philos Trans R Soc B 2016;371:20160007. https://doi.org/10.1098/rstb.2016.0007.
[152] Friston K. The free-energy principle: a rough guide to the brain? Trends Cogn Sci 2009;13:293–301. https://doi.org/10.1016/j.tics.2009.04.005.
[153] Seth AK. Interoceptive inference, emotion, and the embodied self. Trends Cogn Sci 2013;17:565–73. https://doi.org/10.1016/j.tics.2013.09.007.
[154] Pezzulo G, Rigoli F, Friston KJ. Hierarchical active inference: a theory of motivated control. Trends Cogn Sci 2018. https://doi.org/10.1016/j.tics.2018.01.009.
[155] Owens AP, Allen M, Ondobaka S, Friston KJ. Interoceptive inference: from computational neuroscience to clinic. Neurosci Biobehav Rev 2018;90:174–83. https://doi.org/10.1016/j.neubiorev.2018.04.017.
[156] Fuchs T. The circularity of the embodied mind. Front Psychol 2020;11.
[157] Fuchs T, De Jaegher H. Enactive intersubjectivity: participatory sense-making and mutual incorporation. Phenomenol Cogn Sci 2009;8:465–86. https://doi.org/10.1007/s11097-009-9136-4.
[158] Gallese V. Mirror neurons, embodied simulation, and the neural basis of social identification. Psychoanal Dialogues 2009;19:519–36. https://doi.org/10.1080/10481880903231910.
[159] Fuchs T. The phenomenology and development of social perspectives. Phenomenol Cogn Sci 2013;12:655–83. https://doi.org/10.1007/s11097-012-9267-x.
[160] Gallagher S. Direct perception in the intersubjective context. Conscious Cogn 2008;17:535–43.
[161] Gallagher S. Action and interaction. Oxford University Press; 2020.
[162] Friston KJ, Shiner T, FitzGerald T, Galea JM, Adams R, Brown H, et al. Dopamine, affordance and active inference. PLoS Comput Biol 2012. https://doi.org/10.1371/journal.pcbi.1002327.
[163] Friston KJ, Lin M, Frith CD, Pezzulo G, Hobson JA, Ondobaka S. Active inference, curiosity and insight. Neural Comput 2017. https://doi.org/10.1162/NECO_a_00999.
[164] Gallagher S, Allen M. Active inference, enactivism and the hermeneutics of social cognition. Synthese 2018;195:2627–48. https://doi.org/10.1007/s11229-016-1269-8.
[165] Kaplan R, Friston KJ. Planning and navigation as active inference. Biol Cybern 2018. https://doi.org/10.1007/s00422-018-0753-2.
[166] Veissière SPL, Constant A, Ramstead MJD, Friston KJ, Kirmayer LJ. Thinking through other minds: a variational approach to cognition and culture. Behavioral and Brain Sciences 2020;43:e90. https://doi.org/10.1017/S0140525X19001213.
[167] Colombo M, Wright C. First principles in the life sciences: the free-energy principle, organicism, and mechanism. Synthese 2021;198:3463–88. https://doi.org/10.1007/s11229-018-01932-w.
[168] Freud S. Beyond the pleasure principle. Penguin UK; 2003.
[169] Adams RA, Shipp S, Friston KJ. Predictions not commands: active inference in the motor system. Brain Struct Funct 2013;218:611–43. https://doi.org/10.1007/s00429-012-0475-5.
[170] Adams RA, Stephan KE, Brown HR, Frith CD, Friston KJ. The computational anatomy of psychosis. Front Psychiatry 2013;4. https://doi.org/10.3389/fpsyt.2013.00047.
[171] Brown H, Adams RA, Parees I, Edwards M, Friston K. Active inference, sensory attenuation and illusions. Cogn Process 2013. https://doi.org/10.1007/s10339-013-0571-3.
[172] Friston K, Rigoli F, Ognibene D, Mathys C, Fitzgerald T, Pezzulo G. Active inference and epistemic value. Cogn Neurosci 2015. https://doi.org/10.1080/17588928.2015.1020053.
[173] Hohwy J. The Self-Evidencing Brain. Noûs 2016;50:259–85. https://doi.org/10.1111/nous.12062.
[174] Hopkins J. Free energy and virtual reality in neuroscience and psychoanalysis: a complexity theory of dreaming and mental disorder. Front Psychol 2016;7:922.
[175] Yufik YM, Friston K. Life and understanding: the origins of "understanding" in self-organizing nervous systems. Front Syst Neurosci 2016;10:98.
[176] Sarasso P, Neppi-Modona M, Sacco K, Ronga I. Stopping for knowledge": the sense of beauty in the perception-action cycle. Neurosci Biobehav Rev 2020;118:723–38. https://doi.org/10.1016/j.neubiorev.2020.09.004.
[177] Sarasso P, Ronga I, Pistis A, Forte E, Garbarini F, Ricci R, et al. Aesthetic appreciation of musical intervals enhances behavioural and neurophysiological indexes of attentional engagement and motor inhibition. Sci Rep 2019;9:18550. https://doi.org/10.1038/s41598-019-55131-9.
[178] Cohen JD, McClure SM, Yu AJ. Should I stay or should I go? How the human brain manages the trade-off between exploitation and exploration. Philos Trans R Soc B 2007. https://doi.org/10.1098/rstb.2007.2098.
[179] Gottlieb J. Attention, Learning, and the Value of Information. Neuron 2012;76:281–95. https://doi.org/10.1016/j.neuron.2012.09.034.
[180] Barbieri P, Sarasso P, Lodico F, Aliverti A, Murayama K, Sacco K, et al. The aesthetic valve: how aesthetic appreciation may switch emotional states from anxiety to curiosity. Philos Trans R Soc B 2023;379:20220413. https://doi.org/10.1098/rstb.2022.0413.
[181] Sarasso P, Ronga I, Neppi-Modona M, Sacco K. The role of musical aesthetic emotions in social adaptation to the Covid-19 pandemic. Front Psychol 2021;12:445.
[182] Auksztulewicz R, Barascud N, Cooray G, Nobre AC, Chait M, Friston K. The Cumulative Effects of Predictability on Synaptic Gain in the Auditory Processing Stream. J Neurosci 2017;37:6751. https://doi.org/10.1523/JNEUROSCI.0291-17.2017.
[183] Feldman H, Friston KJ. Attention, uncertainty, and free-energy. Front Hum Neurosci 2010. https://doi.org/10.3389/fnhum.2010.00215.
[184] Brown HR, Friston KJ. Dynamic causal modelling of precision and synaptic gain in visual perception - an EEG study. Neuroimage 2012;63:223–31. https://doi.org/10.1016/j.neuroimage.2012.06.044.
[185] Auksztulewicz R, Friston K. Attentional enhancement of auditory mismatch responses: a DCM/MEG study. Cereb Cortex 2015;25:4273–83. https://doi.org/10.1093/cercor/bhu323.
[186] Parr T, Friston KJ. The anatomy of inference: generative models and brain structure. Front Comput Neurosci 2018;12.
[187] Yon D, Frith CD. Precision and the Bayesian brain. Curr Biol 2021;31:R1026–32. https://doi.org/10.1016/j.cub.2021.07.044.
[188] Holmes J, Nolte T. Surprise" and the Bayesian brain: implications for psychotherapy theory and practice. Front Psychol 2019;10:592.
[189] Haken H. Synergetics. Phys Bull 1977;28:412.
[190] Ciompi L, Tschacher W. Affect-logic, embodiment, synergetics, and the free energy principle: new approaches to the understanding and treatment of schizophrenia. Entropy 2021;23. https://doi.org/10.3390/e23121619.
[191] Schiepek G, Tschacher W. Application of synergetics to clinical psychology. Self-organization and clinical psychology: empirical approaches to synergetics in psychology. Springer; 1992. p. 3–31.
[192] Tschacher W, Scheier C. Complex psychological systems: synergetics and chaos. The psychological meaning of chaos: translating theory into practice. Washington, DC, US: American Psychological Association; 1997. p. 273–98. https://doi.org/10.1037/10240-011.
[193] Tschacher W, Junghan UM. Next step, synergetics? Behav Brain Sci 2001;24:66–7. https://doi.org/10.1017/S0140525X01523912.
[194] Tschacher W, Dauwalder J-P. Dynamics, synergetics, autonomous agents: nonlinear systems approaches to cognitive psychology and cognitive science, 8. World Scientific; 1999.
[195] Haken H, Schiepek G. Synergetik in der psychologie: selbstorganisation verstehen und gestalten, 780. Göttingen: Hogrefe; 2006.
[196] Tschacher W, Scheier C, Grawe K. Order and pattern formation in psychotherapy. Nonlinear Dyn Psychol Life Sci 1998;2:195–215.
[197] Ditzinger T, Haken H. A Synergetic Model of Multistability in Perception. editors. In: Kruse P, Stadler M, editors. Ambiguity in mind and nature. Berlin, Heidelberg: Springer Berlin Heidelberg; 1995. p. 255–74.
[198] Kruse P, Strüber D, Stadler M. The Significance of Perceptual Multistability for Research on Cognitive Self-Organization. editors. In: Kruse P, Stadler M, editors. Ambiguity in mind and nature. Berlin, Heidelberg: Springer Berlin Heidelberg; 1995. p. 69–84.
[199] Schiepek GK, Tominschek I, Heinzel S. Self-organization in psychotherapy: testing the synergetic model of change processes. Front Psychol 2014;5.
[200] Haken H, Tschacher W. Theoretical model of intentionality. Mind and Matter 2010;8:7–18.

[201] Tschacher W, Haken HA. Complexity Science Account of Humor. Entropy 2023;25. https://doi.org/10.3390/e25020341.
[202] Mousavi Z., Kiani M.M., Aghajan H. Brain signatures of surprise in EEG and MEG data. BioRxiv 2020:2020.01.06.895664. https://doi.org/10.1101/2020.01.06.895664.
[203] Joffily M, Coricelli G. Emotional valence and the free-energy principle. PLoS Comput Biol 2013;9. https://doi.org/10.1371/journal.pcbi.1003094.
[204] Tschacher W, Haken H. Intentionality in non-equilibrium systems? The functional aspects of self-organized pattern formation. New Ideas Psychol 2007;25:1–15.
[205] Schneider ED, Kay JJ. Life as a manifestation of the second law of thermodynamics. Math Comput Model 1994;19:25–48.
[206] Haken H, Tschacher W. The transfer of principles of non-equilibrium physics to embodied cognition. Implic Embodiment 2011:75–88.
[207] Haken H, Tschacher W. How to modify psychopathological states? Hypotheses based on complex systems theory. Nonlinear Dyn Psychol Life Sci 2017;21:19–34.
[208] Gibson JJ. The theory of affordances. Hilldale, USA 1977;1:67–82.
[209] Scheffer M, Bolhuis JE, Borsboom D, Buchman TG, Gijzel SMW, Goulson D, et al. Quantifying resilience of humans and other animals. Proc Natl Acad Sci 2018;115:11883–90.
[210] Kelso S. Instabilities and phase transitions in human brain and behavior. Front Hum Neurosci 2010;4:1622.
[211] MGM Olde Rikkert, Dakos V, Buchman TG, de Boer R, Glass L, Cramer AOJ, et al. Slowing down of recovery as generic risk marker for acute severity transitions in chronic diseases. Crit Care Med 2016;44:601–6.
[212] Schöller H, Viol K, Aichhorn W, Hütt M-T, Schiepek G. Personality development in psychotherapy: a synergetic model of state-trait dynamics. Cogn Neurodyn 2018;12:441–59.
[213] Isomura T, Parr T, Friston K. Bayesian filtering with multiple internal models: toward a theory of social intelligence. Neural Comput 2019;31:2390–431.
[214] Palacios ER, Isomura T, Parr T, Friston K. The emergence of synchrony in networks of mutually inferring neurons. Sci Rep 2019;9:6412. https://doi.org/10.1038/s41598-019-42821-7.
[215] McCullough L. Treating affect phobia: a manual for short-term dynamic psychotherapy. Guilford Press; 2003.
[216] Lord S. Moments of meeting in psychoanalysis: interaction and change in the therapeutic encounter (1st ed.). Routledge; 2017.
[217] Francesetti G, Alcaro A, Settanni M. Panic disorder: attack of fear or acute attack of solitude? Convergences between affective neuroscience and phenomenological-Gestalt perspective. Res Psychother 2020. https://doi.org/10.4081/ripppo.2020.421.
[218] Ramstead MJD, Badcock PB, Friston KJ. Answering Schrödinger's question: a free-energy formulation. Phys Life Rev 2018;24:1–16.
[219] Sengupta B, Tozzi A, Cooray GK, Douglas PK, Friston KJ. Towards a neuronal gauge theory. PLoS Biol 2016;14:e1002400.
[220] Van de Cruys S, Damiano C, Boddez Y, Król M, Goetschalckx L, Wagemans J. Visual affects: linking curiosity, Aha-Erlebnis, and memory through information gain. Cognition 2021;212:104698. https://doi.org/10.1016/j.cognition.2021.104698.
[221] Lutz A, Mattout J, Pagnoni G. The epistemic and pragmatic value of non-action: a predictive coding perspective on meditation. Curr Opin Psychol 2019;28:166–71.
[222] Sun Z, Firestone C. The Dark Room Problem. Trends Cogn Sci 2020;24:346–8. https://doi.org/10.1016/j.tics.2020.02.006.
[223] Schwartenbeck P, Passecker J, Hauser TU, FitzGerald THB, Kronbichler M, Friston KJ. Computational mechanisms of curiosity and goal-directed exploration. Elife 2019;8:e41703. https://doi.org/10.7554/eLife.41703.
[224] Chetverikov A, Kristjánsson Á. On the joys of perceiving: affect as feedback for perceptual predictions. Acta Psychol (Amst) 2016;169:1–10. https://doi.org/10.1016/j.actpsy.2016.05.005.
[225] Van de Cruys S. Affective value in the predictive mind. Philos Predictive Process 2017:1–21. https://doi.org/10.15502/9783958573253.
[226] McReynolds P. The Three Faces of Cognitive Motivation. Intrinsic motivation. : a new direction in education. Toronto: Holt, Rinehart and Winston; 1971.
[227] Oudeyer P-Y, Smith LB. How evolution may work through curiosity-driven developmental process. Top Cogn Sci 2016;8:492–502. https://doi.org/10.1111/tops.12196.
[228] Friston K, Breakspear M, Deco G. Perception and self-organized instability. Front Comput Neurosci 2012;6:44.
[229] Anderson EC, Carleton RN, Diefenbach M, Han PKJ. The relationship between uncertainty and affect. Front Psychol 2019. https://doi.org/10.3389/fpsyg.2019.02504.
[230] Sajid N, Parr T, Hope TM, Price CJ, Friston KJ. Degeneracy and redundancy in active inference. Cerebral Cortex 2020;30:5750–66.
[231] Roli A, Villani M, Filisetti A, Serra R. Dynamical criticality: overview and open questions. J Syst Sci Complex 2018;31:647–63.
[232] Van de Cruys S, Bervoets J, Moors A. Preferences need inferences: learning, valuation, and curiosity in aesthetic experience. PsyArXiv Preprints 2021. https://doi.org/10.31234/osf.io/zh6nt.
[233] Recalcati M. Le nuove melanconie: destini del desiderio nel tempo ipermoderno. Raffaello Cortina Editore; 2019.
[234] de Felice G, Orsucci FF, Scozzari A, Gelo O, Serafini G, Andreassi S, et al. What differentiates poor and good outcome psychotherapy? a statistical-mechanics-inspired approach to psychotherapy research. Systems (Basel) 2019;7. https://doi.org/10.3390/systems7020022.
[235] Badcock PB, Davey CG, Whittle S, Allen NB, Friston KJ. The depressed brain: an evolutionary systems theory. Trends Cogn Sci 2017;21:182–94. https://doi.org/10.1016/j.tics.2017.01.005.
[236] Constant A, Hesp C, Davey CG, Friston KJ, Badcock PB. Why depressed mood is adaptive: a numerical proof of principle for an evolutionary systems theory of depression. Comput Psychiatr 2021;5:60–80. https://doi.org/10.5334/cpsy.70.
[237] Abramson LY, Seligman ME, Teasdale JD. Learned helplessness in humans: critique and reformulation. J Abnorm Psychol 1978;87:49–74.
[238] Smith R, Badcock P, Friston KJ. Recent advances in the application of predictive coding and active inference models within clinical neuroscience. Psychiatry Clin Neurosci 2021;75:3–13. https://doi.org/10.1111/pcn.13138.
[239] Kiverstein J, Miller M, Rietveld E. How mood tunes prediction: a neurophenomenological account of mood and its disturbance in major depression. Neurosci Conscious 2020;2020. https://doi.org/10.1093/nc/niaa003.
[240] Aaronson ST, Sears P, Ruvuna F, Bunker M, Conway CR, Dougherty DD, et al. A 5-year observational study of patients with treatment-resistant depression treated with vagus nerve stimulation or treatment as usual: comparison of response, remission, and suicidality. Am J Psychiatry 2017;174:640–8. https://doi.org/10.1176/appi.ajp.2017.16010034.
[241] Dunn BD, Dalgleish T, Ogilvie AD, Lawrence AD. Heartbeat perception in depression. Behav Res Ther 2007;45:1921–30.
[242] Furman DJ, Waugh CE, Bhattacharjee K, Thompson RJ, Gotlib IH. Interoceptive awareness, positive affect, and decision making in major depressive disorder. J Affect Disord 2013;151:780–5.
[243] Harshaw C. Alimentary epigenetics: a developmental psychobiological systems view of the perception of hunger, thirst and satiety. Dev Rev 2008;28:541–69.
[244] Paulus MP, Stein MB. Interoception in anxiety and depression. Brain Struct Funct 2010;214:451–63.
[245] Drevets WC, Price JL, Furey ML. Brain structural and functional abnormalities in mood disorders: implications for neurocircuitry models of depression. Brain Struct Funct 2008;213:93–118.
[246] Vizueta N, Rudie JD, Townsend JD, Torrisi S, Moody TD, Bookheimer SY, et al. Regional fMRI hypoactivation and altered functional connectivity during emotion processing in nonmedicated depressed patients with bipolar II disorder. Am J Psychiatry 2012;169:831–40.
[247] Wang L, Hermens DF, Hickie IB, Lagopoulos J. A systematic review of resting-state functional-MRI studies in major depression. J Affect Disord 2012;142:6–12.
[248] Brewer R, Murphy J, Bird G. Atypical interoception as a common risk factor for psychopathology: a review. Neurosci Biobehav Rev 2021;130:470–508. https://doi.org/10.1016/j.neubiorev.2021.07.036.
[249] Francesetti G, Roubal J. Gestalt therapy approach to depressive experiences. Psychotherapie-Wissenschaft 2020:39–45.
[250] Fonagy P, Allison E. The role of mentalizing and epistemic trust in the therapeutic relationship. Psychotherapy 2014;51:372.
[251] Fonagy P, Allison E. The role of mentalizing and epistemic trust in the therapeutic relationship. Psychotherapy 2014;51:372.
[252] Orme W, Bowersox L, Vanwoerden S, Fonagy P, Sharp C. The relation between epistemic trust and borderline pathology in an adolescent inpatient sample. Borderline Personal Disord Emot Dysregul 2019;6:1–9.

[253] Fonagy P, Luyten P, Allison E. Epistemic petrification and the restoration of epistemic trust: a new conceptualization of borderline personality disorder and its psychosocial treatment. J Pers Disord 2015;29:575–609.
[254] Bo S, Sharp C, Fonagy P, Kongerslev M. Hypermentalizing, attachment, and epistemic trust in adolescent BPD: clinical illustrations. Personality Disord 2017;8:172.
[255] Staemmler F. On cultivating uncertainty: an attitude for gestalt therapists. British Gestalt J 1997;6.
[256] Staemmler F-M. Like a fish in water: gestalt therapy in times of uncertainty. Gestalt Rev 2000;4:205–18. https://doi.org/10.5325/gestaltreview.4.3.0205.
[257] Holmes J. Friston's free energy principle: new life for psychoanalysis? BJPsych Bull 2022;46:164–8. https://doi.org/10.1192/bjb.2021.6.
[258] Holmes J. Friston's free energy principle: new life for psychoanalysis? BJPsych Bull 2022;46:164–8. https://doi.org/10.1192/bjb.2021.6.
[259] Olthof M, Hasselman F, Strunk G, van Rooij M, Aas B, Helmich MA, et al. Critical fluctuations as an early-warning signal for sudden gains and losses in patients receiving psychotherapy for mood disorders. Clin Psychol Sci 2020;8:25–35.
[260] Lutz W, Ehrlich T, Rubel J, Hallwachs N, Röttger M-A, Jorasz C, et al. The ups and downs of psychotherapy: sudden gains and sudden losses identified with session reports. Psychother Res 2013;23:14–24.
[261] Kelly KA, Rizvi SL, Monson CM, Resick PA. The impact of sudden gains in cognitive behavioral therapy for posttraumatic stress disorder. J Traumatic Stress 2009;22:287–93.
[262] Tang TZ, Luborsky L, Andrusyna T. Sudden gains in recovering from depression: are they also found in psychotherapies other than cognitive-behavioral therapy? J Consult Clin Psychol 2002;70:444.
[263] Wichers M, Schreuder MJ, Goekoop R, Groen RN. Can we predict the direction of sudden shifts in symptoms? Transdiagnostic implications from a complex systems perspective on psychopathology. Psychol Med 2019;49:380–7.
[264] Gonçalves MM, Ribeiro AP, Stiles WB, Conde T, Matos M, Martins C, et al. The role of mutual in-feeding in maintaining problematic self-narratives: exploring one path to therapeutic failure. Psychother Res 2011;21:27–40.
[265] Bion WR. Elements of psychoanalysis. Routledge; 2018.
[266] Caro Gabalda I, Stiles WB. Irregular assimilation progress: reasons for setbacks in the context of linguistic therapy of evaluation. Psychother Res 2013;23:35–53.
[267] Schiepek GK, Tominschek I, Heinzel S. Self-organization in psychotherapy: testing the synergetic model of change processes. Front Psychol 2014;5:1089.
[268] Schiepek GK, Viol K, Aichhorn W, Hütt M-T, Sungler K, Pincus D, et al. Psychotherapy is chaotic—(not only) in a computational world. Front Psychol 2017;8:379.
[269] Kowalik Z, Schiepek G, Kumpf K, Roberts L, Elbert T. Psychotherapy as a chaotic process II. The application of nonlinear analysis methods on quasi time series of the client-therapist interaction: a nonstationary approach. Psychother Res 1997;7:197–218.
[270] Gumz A, Bauer K, Brähler E. Corresponding instability of patient and therapist process ratings in psychodynamic psychotherapies. Psychother Res 2012;22:26–39.
[271] de Felice MSc G. How is the shape of change in the psychotherapeutic complex system? Chaos Complex Lett 2014;8:109.
[272] Gumz A, Kästner D, Geyer M, Wutzler U, Villmann T, Brähler E. Instability and discontinuous change in the experience of therapeutic interaction: an extended single-case study of psychodynamic therapy processes. Psychother Res 2010;20:398–412.
[273] Schiepek G, Gelo O, Viol K, Kratzer L, Orsucci F, de Felice G, et al. Complex individual pathways or standard tracks? A data-based discussion on the trajectories of change in psychotherapy. Couns Psychother Res 2020;20:689–702. https://doi.org/10.1002/capr.12300.
[274] Schiepek G, Aichhorn W, Gruber M, Strunk G, Bachler E, Aas B. Real-time monitoring of psychotherapeutic processes: concept and compliance. Front Psychol 2016;7.
[275] Schiepek G, Stöger-Schmidinger B, Kronberger H, Aichhorn W, Kratzer L, Heinz P, et al. The Therapy Process Questionnaire - Factor analysis and psychometric properties of a multidimensional self-rating scale for high-frequency monitoring of psychotherapeutic processes. Clin Psychol Psychother 2019;26:586–602. https://doi.org/10.1002/cpp.2384.
[276] de Felice G, Giuliani A, Pincus D, Scozzari A, Berardi V, Kratzer L, et al. Stability and flexibility in psychotherapy process predict outcome. Acta Psychol (Amst) 2022;227:103604. https://doi.org/10.1016/j.actpsy.2022.103604.
[277] de Felice G, Giuliani A, Gelo OCG, Mergenthaler E, De Smet MM, Meganck R, et al. What differentiates poor- and good-outcome psychotherapy? a statistical-mechanics-inspired approach to psychotherapy research, part two: network analyses. Front Psychol 2020;11.
[278] Orsucci FF, Musmeci N, Aas B, Schiepek G, Reda MA, Canestri L, et al. Synchronization analysis of language and physiology in human dyads. Nonlinear Dyn Psychol Life Sci 2016;20:167–91.
[279] Orsucci F. Human synchronization maps-the hybrid consciousness of the embodied mind. Entropy (Basel) 2021;23. https://doi.org/10.3390/e23121569.
[280] Orsucci F. Changing mind: transitions in natural and artificial environments. World Scientific; 2002.
[281] Langs R. The bipersonal field. J. Aronson; 1976.
[282] Carhart-Harris RL, Friston KJ. The default-mode, ego-functions and free-energy: a neurobiological account of Freudian ideas. Brain 2010;133:1265–83.
[283] van Elk M, DB Yaden. Pharmacological, neural, and psychological mechanisms underlying psychedelics: a critical review. Neurosci Biobehav Rev 2022;140:104793. https://doi.org/10.1016/j.neubiorev.2022.104793.
[284] Herzog R, Mediano PAM, Rosas FE, Lodder P, Carhart-Harris R, Perl YS, et al. A whole-brain model of the neural entropy increase elicited by psychedelic drugs. Sci Rep 2023;13:6244. https://doi.org/10.1038/s41598-023-32649-7.
[285] Kadriu B, Greenwald M, Henter ID, Gilbert JR, Kraus C, Park LT, et al. Ketamine and serotonergic psychedelics: common mechanisms underlying the effects of rapid-acting antidepressants. Int J Neuropsychopharmacol 2021;24:8–21. https://doi.org/10.1093/ijnp/pyaa087.
[286] Timmermann C, Bauer PR, Gosseries O, Vanhaudenhuyse A, Vollenweider F, Laureys S, et al. A neurophenomenological approach to non-ordinary states of consciousness: hypnosis, meditation, and psychedelics. Trends Cogn Sci 2023;27:139–59. https://doi.org/10.1016/j.tics.2022.11.006.
[287] Marguilho M, Figueiredo I, Castro-Rodrigues P. A unified model of ketamine's dissociative and psychedelic properties. J Psychopharmacol 2022;37:14–32. https://doi.org/10.1177/02698811221140011.
[288] Sarasso P, Billeci M, Ronga I, Raffone F, Martiadis V, Di Petta G. Disembodiment and affective resonances in esketamine treatment of depersonalized depression subtype: two case studies. Psychopathology 2024:1–12. https://doi.org/10.1159/000539714.
[289] Cavarra M, Falzone A, Ramaekers JG, Kuypers KPC, Mento C. Psychedelic-assisted psychotherapy—a systematic review of associated psychological interventions. Front Psychol 2022;13.