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Special review article

Mindscape: A convergent perspective on life, mind, consciousness and happiness

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ABSTRACT

What are mind, consciousness and happiness, in the fundamental context of life? We propose a convergent perspective (coupling evolutionary biology, genomics, neurobiology and clinical medicine) that could help us better understand what life, mind, consciousness and happiness are, as well as provides empirically testable practical implications.

Contents

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1. Life, mind, consciousness and happiness: a theoretical framework

"It is always advisable to perceive clearly our ignorance".
-Charles Darwin

What are mind, consciousness and happiness, in the fundamental context of life? Diverse answers have been provided by scientists and philosophers. The answers to date may not be fully explanatory and/or practical enough in nature. We propose that a theoretical framework(Crick and Koch, 2003) encompassing a convergent perspective (coupling evolutionary biology, genomics, neurobiology and clinical medicine) could help us better understand what life, mind, consciousness and happiness are, as well as provides empirically testable practical implications. We perceive clearly our ignorance in multiple fields not accounted for in our approach, but wish to outline it nevertheless as a possible step in the right direction, and a starting point for future discussions and explorations.

2. What is life?

"Simplex sigillum veri (Simplicity is the hallmark of truth)".
-Latin proverb

We would like to propose, in a hardly original but perhaps more explicit fashion, that life is about reproducing genes (*G*) and providing a proximal (*u*) and general (*U*) umbrella for them, to ensure their survival, propagation and thriving. The necessary and sufficient condition for an entity to be considered alive may be for it to have the capacity to reproduce and propagate parts of self encoded in the genetic material (*G*)(Dawkins, 1978). This definition could include informational entities like memes (Bull et al., 2000) or software viruses, whose genetic material equivalent consists of computer code. However, two additional functions have evolved in most living organisms to accompany the *G* function and provide an umbrella-like protection against adversity. One is local improvement of the (micro) environment (proximal umbrella, *u*), to provide short-term protection to *G* until reproduction and immediate protection to progeny after reproduction. The other is global improvement of the (macro) environment (general umbrella, *U*) to provide long-term protection to *G* and multiple generations of progeny. *G* with favorable *u* and *U* has increased chances of surviving and propagating in the long-term. *U* and *u* may explain altruism in general, and self-sacrifice for extended kin (Silk et al., 2005) in particular.

3. What are mind, consciousness and happiness?

"You do not win battles by debating exactly what is meant by the word battle. You need to have good troops, good weapons, a good strategy, and then hit the enemy hard. The same applies to solving a difficult scientific problem".
- Francis Crick

We propose that the mind can be viewed as a composite of mechanisms that have evolved to achieve *GuU* objectives. The latest genetic, neurobiological and clinical evidence suggest that normal mental functioning and psychiatric disorders can be classified in three broad and overlapping domains: the anxiety domain, the mood domain and the cognitive domain (Niculescu, 2006) (Fig. 1), somewhat paralleling the archaic Freudian constructs of id, ego and super-ego. The mind works to optimize organism–environment interactions through anxiety, mood and cognition. Psychiatry can provide a magnifying glass for identifying the normal functions of the mind by studying its disruptions, just as the study of transgenic mice is useful for understanding normal gene function (Le-Niculescu et al., 2008). The converging evidence to date suggests that:

- Anxiety is about *reactivity* (Flaa et al., 2007; Hovatta et al., 2005; Zhou et al., 2008) in the face of uncertainty and potential danger—monitoring external environmental changes or internal milieu changes in order to detect dangers to *GuU* in general, with a strong focus on *G*. Thus, broadly speaking, we have two types of anxiety disorders: externally driven (such as post-traumatic stress disorders and phobias), and internally driven (such as generalized anxiety disorders and panic attacks). Past events, depending on their *GuU* salience and the genetic make-up of the organism, can modify the reactivity threshold for response to future stimuli, leading either to sensitization (over-reactivity and anticipatory anxiety) or to tolerance (under-reactivity and emotional numbness).
- Mood is about *trophicity* (Niculescu, 2005), through energy metabolism and cellular growth, reacting to a favorable, stimulating environment by activity and expansion, and to an unfavorable, deprived environment by inactivity and retraction (Le-Niculescu et al., 2009a,b). It is involved in achieving *GuU*, with a strong impact on *u*. Mood is a reflection of the availability of resources in the external and internal environment, and thus permits the

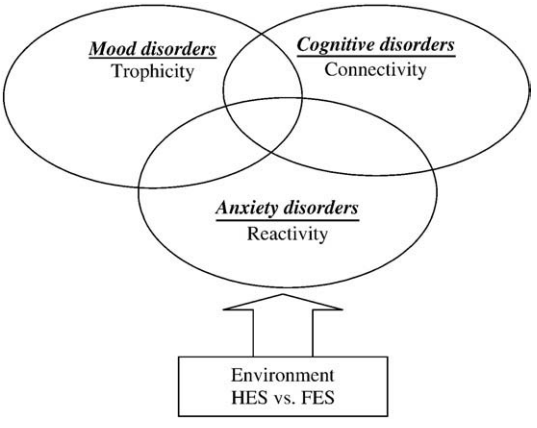

Fig. 1. Overlap and interdependence: Venn diagram.

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organism to attune bi-directionally with the environment. High resources translate into high mood and high libido, as the environment is favorable, provides an umbrella for one's genes, and can support more cell proliferation, expansion and progeny. The threshold for pain may be elevated (Ogden et al., 2004), so the favorable environment can be taken advantage of and activity can occur even in the face of actual injuries. Conversely, low resources translate into a low mood and low libido, as the environment is unfavorable and cannot support more cell proliferation, expansion and progeny. The threshold for pain is reduced, so the organism can curtail activity and retract in the face of potential injuries (Nesse, 2000; Niculescu and Akiskal, 2001a,b).

- Cognition is about *connectivity* and congruence—within the organism, and with the environment (Izhikevich and Edelman, 2008; Le-Niculescu et al., 2007; Seth et al., 2006). It is involved in achieving *GuU*, with a strong impact on *U*. Cognition is a reflection of an organism's congruence within itself, and with the outside world, and thus impacts its ability to make a contribution to the broader environment/society at large. While this at first glance may seem an altruistic function, it is a way to provide a general, longer-term umbrella for one's genes and extended kin.
- Consciousness is about *monitoring* the environment through the mind (anxiety, mood and cognition), sensing if the environment is favorable or not to the *GuU* process. This is achieved through sensing changes in the type or intensity of stimuli from the internal milieu or from the external environment, and translating these changes into pleasure/contentment if the environment is favorable or pain/discomfort if the environment is unfavorable ("the feeling of what happens") (Damasio, 2003).
- Happiness is about *achieving GuU* objectives. What determines the benchmarks for *GuU* objectives being achieved? And are these benchmarks fixed through life? We suggest that some of the benchmarks are hardwired, especially in regards to *G*, and some are environmentally determined, especially in regards to *U*. As an organism ages, levels of happiness tend to increase as more and more of the objectives are achieved.

4. Whole-organism effects

"Studies at higher system levels are likely to inform those at the simpler level of the cell and vice versa".
- Paul Nurse

Does the mind have effects on the rest of the body, or do similar mind-like mechanisms occur in other parts of the body, at different levels (Nurse, 2008)? The answer is probably both. There is emerging evidence that genes involved in somatic disorders and brain disorders overlap (Torkamani et al., 2008), and that peripheral blood biomarkers can provide a window into brain functioning (Le-Niculescu et al., 2009a). While the later creates opportunities for diagnostics, the former creates both opportunities and challenges for therapeutics, due to the potential pleiotropic effects of medications (Table 1).

Table 1
Mind disorders, whole-organism co-morbidities and testable potential therapeutic implications.

Mind disorders	Cellular physio-pathology	Whole-organism co-morbid disorders	Testable potential therapeutic implications
Anxiety disorders (panic disorder, post-traumatic stress disorder (PTSD), et al.)	***Reactivity*** to stimuli (*signal transduction*) (Hovatta et al., 2005; Zhou et al., 2008), pH, reactive oxygen species	Allergies, inflammation, irritable bowel syndrome, hypertension (Wang et al., 2009) *Carcinogenesis*	Acute anxiety disorders (such as panic disorder, post-traumatic stress disorder exacerbations) can have an explosive, allergy/anaphylactic type phenomenology. Shared molecular pathways—more allergies, inflammation in anxiety disorder patients? Use anti-allergic, anti-inflammatory medications to treat anxiety? Chronic anxiety disorders (such as generalized anxiety disorder) have constant high levels of being tense, similar to chronic hypertension. Shared molecular pathways—more hypertension in anxiety disorder patients? Use anti-hypertensive medications to treat anxiety? Use anti-anxiety medications to treat hypertension?
Mood disorders (bipolar disorder, major depressive disorder, et al.)	***Trophicity***, cell division (*cell cycle,*)(Le-Niculescu et al., 2009a), metabolic rate (*mitochondria function*) (Kato and Kato, 2000)	Pain syndromes, eating disorders, endocrine disorders *Tumor growth/proliferation/apoptosis*	More mood disorders in pain disorders, eating disorders, body dysmorphia, endocrine disorders, cancer? Shared molecular pathways—use pain, hormonal and anti-cancer medications to treat mood disorders? Use mood medications to treat pain, endocrine disorders and cancer?
Cognitive disorders (schizophrenia, autism, et al.)	***Connectivity*** (Le-Niculescu et al., 2007) of cellular systems to ensure internal congruence and congruence with environment. (for example, *cell adhesion*)	Degenerative disorders Metastasis	More schizophrenia in metabolic and degenerative disorders? Shared molecular pathways? Use anti-dismetabolic, anti-degenerative medications to treat schizophrenia? Use schizophrenia drugs to treat degenerative disorders?

Due to complexity, heterogeneity, overlap and interdependence between these disorders, the delineation is not absolute. For example, different aspects of cancer (initiation, proliferation, and metastasis), may be associated with different aspects of the cellular mind.

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We propose that mind, consciousness and happiness, readily recognizable at a human organism level as functions of the brain, may hold true in a more rudimentary form at an organ and cellular level (Table 1). As such, we postulate that they are not restricted to humans or primates, but exist in some form starting with unicellular organisms, and evolve in complexity along with the organism. As an example of how the cellular-level mind interplays with disease process, the initiation of cancer (carcinogenesis) can be viewed as a function of excessive cellular reactivity/anxiety, the proliferation (tumor growth) as a function of excessive cellular trophicity/mood, and the dissociation and spreading (metastasis) as a malfunction of cellular connectivity/cognition. While cancer may be achieving some *Gu* objective of the tumor cells, it does not achieve *U* and is at odds with the *GuU* objectives of the more complex multi-cellular organism.

On a more philosophical note, this systems-level view can also be extended to the macro realm of social sciences, by looking at efforts to achieve *GuU* at a family level, societal level and national level. Individualism vs. the greater social good can be viewed as having the same dynamic tension as that between cellular *GuU* objectives and complex multi-cellular organism *GuU* objectives.

5. Environment effects

> "The brain, like an evolutionary garden, consists of myriad regions and neural patterns linked …by large scale connection patterns and complex interactions—regional and global. These patterns are selected during behaviors that are adaptive".
> -Gerald M. Edelman

The environment can be favorable or not to the organisms' life objectives (*GuU*). It is perceived by the mind (anxiety, mood, and cognition) as it impacts the brain and the whole organism, which adapt to it. Pleasure and contentment (reward) occur if the environment is favorable to *GuU* (Favorable Environment State- FES). Pain and discomfort (aversion) occur if the environment is hostile to *GuU* (Hostile Environment State/Syndrome-HES) (Fig. 1). Memories are formed in relationship to environmental exposure, modulating responses the next time the stimulus is encountered.

At a cellular level, FES leads to terminal differentiation and specialization. HES leads to de-differentiation and reverting to a pluripotential state, trying to improve chances for adaptation and survival in a changing and challenging environment. At a brain level, the core neurobiology of myelination, cell adhesion and synaptic connections is strengthened by FES (rest (Gally and Edelman, 2004), nutrition, and exercise), and weakened by HES (fatigue, malnutrition, and stress) (Le-Niculescu et al., 2008). A resilient core provides protection in the face of HES.

HES, on the pathological side, deserves examination as a common trigger for illness, with whole-organism reaction consequences. In humans, examples include inflammation (von Kanel et al., 2007), autoimmune disorders (Dube et al., 2009), metabolic syndrome (Heppner et al., 2009), cardiovascular disorders (von Kanel et al., 2006; Wang et al., 2009) and psychiatric disorders (Pfeffer et al., 2007). On the physiological side, HES may lead to resilience through hormesis (Rodd et al., 2007). In our view, acute overwhelming HES plus susceptibility genes for illness lead to pathology, such as a whole-body post-traumatic stress disorder (PTSD), whereas chronic manageable HES plus protective genes for illness may lead to increased physiological robustness, similar to building muscles through exercise. Early development, extending to childhood and adolescence, may be a particularly plastic period for the effects of HES, leading to life-long effects and potentially trans-generational consequences (Evans and Schamberg, 2009).

We propose that three evolutionary factors underlie gene–environment interactions as they pertain to illness. First, *age*. Genes that may provide an evolutionary advantage in early life development leading to procreation may constitute a liability later on in life and contribute to clinical illness. Second, *quantity*. Genes or combinations of genes that provide subtle alterations from the norm in the population may lead to evolutionary advantages. However, if the alteration from the norm is large it becomes disabling and contributes to clinical illness. An important consideration here is that some genetic variants are predisposing for the illness, like oncogenes are in cancer, and some genetic variants are protective against the illness, like tumor-suppressor genes are in cancer. The combinatorial summation of genetic alterations determines whether, and in which direction, alterations from the norm will occur. This conceptualization needs to be applied more broadly beyond cancer, to other polygenic disorders, including psychiatric disorders (Niculescu et al., 2000; III Niculescu, 2006; III Niculescu and Kelsoe, 2001). Third, *environmental fit*. Genes that provide an advantage in certain environments contribute to clinical illness in other environments. In most cases, it is a combination of age, quantity and environmental fit that determines if an organism prospers or becomes ill.

6. Addictions

> "Indulge yourself in pleasures only in so far as they are necessary for the preservation of health".
> - Baruch Spinoza

GuU achievement can be subverted by addictions. From the perspective described in this paper, addictions can be viewed as interactions with the environment that hijack and modulate pleasure/pain mechanisms. They are maladaptive shortcuts to feeling good (pseudo FES), giving an illusion of *GuU* achievement (pseudo *GuU*) without achievement of real *GuU* objectives.

Addictions modulate one or more of the three principal domains of the mind-anxiety, mood or cognition, with indirect impact on the other domains. Examples of addictions are chemical addictions, biological addictions and informational (cultural) addictions. Some addictive products may subserve productive functions, such as food, sex, art, internet use—and only their misuse in terms of the evolutionary factors of age, quantity or environmental fit may lead to addictions. For example, rich food is useful biologically while the organism is developing (age), in moderate quantities (quantity), and in relationship to levels of activity (environmental fit). It can become an addiction in older organisms, in large and escalating quantities that bear no relationship to levels of activity.

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Addictions, as broadly defined, are interwoven with daily life. As such, addictive products can be used, abused, and lead to dependence. Addictive products are used to provide some pleasure and comfort in the time stretches between real *GuU* achievements. The impact of low dose addictive products, used occasionally, may be a constructive one from rest, recreation and regeneration standpoints (a negative feedback loop for fatigue induced by work towards real *GuU*). However, a clear "slippery slope" risk (positive feedback loop for addictions) exists. Sensitization and memory mechanisms are involved in addictions (Kauer and Malenka, 2007).Thus, some individuals upon exposure to addictive products become primed to respond even stronger the next time they are exposed to them. Re-exposure also awakens memories of past pleasurable effects of use, and primes the individuals to seek and use even more.

Addictive products are abused and lead to dependence when they are used more and more, with an inability to cut down, and with withdrawal symptoms if they are stopped(Schuckit, 2009). This is destructive, as it interferes with activities directed at achieving real *GuU* objectives. Tolerance occurs with continued use, due to biological mechanisms de-sensitizing in an attempt by the organism to maintain homeostasis. This phenomenon leads to the need to use more and more to still obtain a pleasurable effect, and to strong withdrawal symptoms if the addictive product is stopped abruptly.

Addictions can occur at all levels of the mind, including cellular mind. For example, cancer can be viewed as a cellular addiction to growth factors.

7. Lifescape and Mindscape

> "The orgy of fact extraction in which everybody is currently engaged has, like most consumer economies, accumulated a vast debt. This is a debt of theory, and some of us are soon going to have an exciting time paying it back — with interest, I hope".
> - Sydney Brenner

The above ideas and paradigms can be modeled using a three-dimensional spatial representation of the life landscape-Lifescape, and of the mental landscape–Mindscape. The three dimensions for the Lifescape are *G, u, U*. The three dimensions for the Mindscape are mood, cognition and anxiety. The axes are not orthogonal, to reflect the interdependence of the three domains. Thus, changes in one dimension translate into changes in the other two dimensions (Fig. 2). For example, changes in the health of an organism (impacting *G*) can influence its ability to accumulate resources (*u*) as well as its ability to influence the broader environment (*U*).

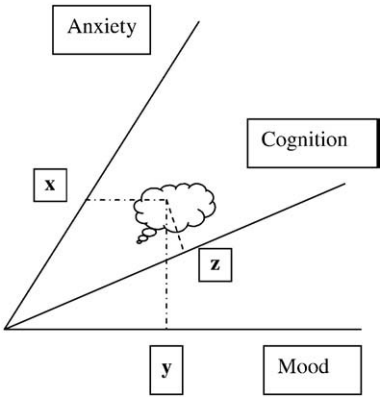

Fig. 2. Mindscape 3D modelling of anxiety, mood and cognition. At each moment in time, an individual is represented by a point with (*x*, *y*, and *z*) coordinates in this tri-dimensional space. The sum of points over time is distributed as a cloud, unique to each individual.

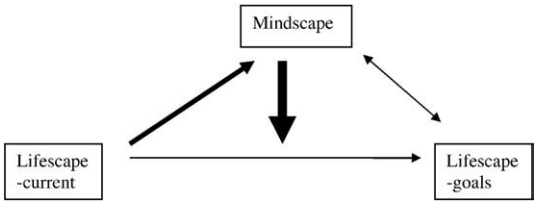

Fig. 3. Mindscape reflects what is happening in Lifescape, and in turn influences what will happen in Lifescape.

Mindscape reflects what is happening in Lifescape, and in turn influences what will happen in Lifescape (Fig. 3). Direct changes in an organisms' Mindscape are often more feasible in the short term than making changes in its Lifescape, and may optimize the Mindscape for positive effects on the Lifescape.

7.1. Mindscape

Z-scores in each of the three dimensions (anxiety, mood, and cognition) will provide the location in Mindscape (*x*, *y*, and *z* coordinates) for each organism at a particular moment in time. That would provide information regarding an organism's *state* (how it is at that particular moment). Repeated testing over time would provide a series of points in Mindscape for each organism. The cloud generated by this series of points, its shape and location would provide information regarding an organisms *trait* (how it is over time). The transition from state to trait is a fluid one, i.e. "state over time" becomes trait. Time can be conceptualized in this model as a fourth dimension. For example, there could be cycling over time between low and high scores in the mood dimension (cyclothymia and bipolar disorder). Less appreciated is the cycling that can occur in the anxiety dimension (cycloanxiety), and in the cognition dimension (cyclocognition), with pathology more evident at night (insomnia, nightmares, and sundowning). These cycling phenomena are likely underlined by circadian clock genes (Le-Niculescu et al., 2008) and have evolutionary roots related to adapting to the environment (taking advantage of FES, being on guard against HES).

Normal functioning is represented by scores clustered around the center of each axis, and points clustered around the central area of the Mindscape. Abnormal functioning (either sub-functional or supra-functional) is represented by scores at the extremes of each axis, and points clustered at the corners of the Mindscape.

While these Mindscape clouds are in part genetically determined, their final shape is heavily sculpted and altered by developmental history (Edelman, 1993)—environment, life

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events, treatments and addictions. A favorable environment (FES) promotes stability and optimal functioning, but can lead over time to hypotrophy (weakness). A hostile environment (HES) may promote efforts to adapt and change, leading to compensatory hypertrophy in resilient individuals or to destructive hypotrophy in vulnerable individuals.

8. Applications

> "For a scientist, it is a unique experience to live through a period in which his field of endeavour comes to bloom — to be witness to those rare moments when the dawn of understanding finally descends upon what appeared to be confusion only a while ago — to listen to the sound of darkness crumbling."
> - George E. Palade

We propose that Mindscape is a useful visual representation model. It can be used on the clinical side to understand psychiatric and, more broadly, medical illnesses (Table 1). As such, it can guide clinical diagnosis and treatment. It can also be used to understand normal personality and temperaments (Cloninger et al., 1993) (Akiskal et al., 2005). The perspectives described in this paper can inform deliberate life choices (personal and professional) in the direction of self-improvement and optimization of performance.

8.1. Mindscape psychiatry

In our view, each psychiatric diagnosis is a composite of anxiety, mood and cognitive abnormalities. These disorders are characterized by genetic *complexity*, with a very large repertoire of genetic mutations being involved, a somewhat smaller number of genes, and, in decremental numbers, biological pathways, mechanisms, and phenes. The scoring can be done based on panels of genes, panels of biomarkers, panels of phenes, or an integration of the three, resulting ultimately in a single score on each Mindscape axis. People with similar broad psychiatric diagnoses can have a variety of topologies (shapes) of clouds, reflecting the genetic *heterogeneity* of these disorders. People with different diagnoses have overlaps between their clouds, reflecting the genetic *overlap* between the different psychiatric diagnoses. Movement of the mind state point in 3D space is projected in movements on all 3 axes. This reflects the genetic *interdependence* between the three Mindscape dimensions: anxiety, mood and cognition. Thus, Mindscape modelling is able to represent and integrate in a simplified fashion the reality of psychiatric disorders as combinatorial Lego game-like complex biological constructs, made up of diverse, often shared, genetic building blocks (Le-Niculescu et al., 2007; Niculescu et al., 2006).

8.2. Mindscape diagnostics

Accurate assessment precedes, and lays the foundation for, targeted treatment. Objective testing could tell earlier and better (more precisely) where a person is in their Mindscape (mental landscape). This can be accomplished with quantitative genetic testing, biomarker testing, phenotypic testing, or a combination of the three. In essence, testing for mood, cognition and anxiety could become like, and use algorithms similar to, actuarial/insurance risk assessment scores.

Genetic testing for mutations in DNA gives the earliest detection of a potential problem even before illness occurs, but it is not very precise, i.e. many genes and environmental factors over time contribute to the manifestation of a phenotype, which may or may not occur. The evolutionary principles of age, quantity and environmental fit discussed above apply. Most single genetic mutations (such as single nucleotide polymorphisms—SNPs) have tenuous connection to the ultimate phenotype. Due to the heterogeneity of the human population and the complexity of most disorders, genetic-only testing is often not powerful and informative enough by itself (Fig. 4).

At the other end, phenotypic testing can be precise, but that is more the case when the disease has already manifested itself, and can be readily diagnosed using clinical criteria. Moreover, a complicating factor can be that people who are ill with psychiatric disorders, such as schizophrenia, may not always report accurately their symptoms to clinicians.

Biomarkers such as gene expression levels (or protein levels) are a reasonable medium between early detection and precision. The interaction of genes and environment leads to gene expression, which is in essence a biological endophenotype (internal building block for phenotype), and underlies the subsequent ultimate manifestation of external phenotype (such as symptomatic clinical illness). As such, with biomarkers only, one could detect things fairly early (allowing for early intervention or prevention efforts) and fairly precisely in terms of relationship to phenotype. Single time-point testing of an individual can provide information related to state and clinical severity. Repeated measures over time can provide information related to response to treatment and trait personalized diagnosis.

Comprehensive approaches, integrating genetic testing, biomarker testing, and phenotypic testing will increase the yield in terms of combining earlier detection with better precision, and trait with state.

8.3. Mindscape therapeutics

The psychiatry of the future will likely rely on personalized tri-dimensional (3D) treatment (concurrent treatment of

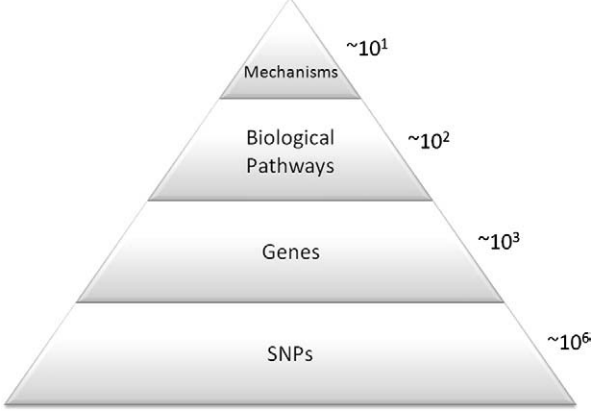

Fig. 4. Genetic heterogeneity and complexity.

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anxiety, mood and cognitive abnormalities) plus modulating environmental factors (increasing FES/HES ratio). A 3D psychopharmacology approach would involve rational polypharmacy (Niculescu, 2006)— the combination of 3 or more medications, each acting primarily on anxiety, mood, and cognition, respectively. Depending on where the major pathology is, modeled by where somebody is in their Mindscape, one or another of the medications is used at higher doses and the others at lower doses. For example, for major cognitive abnormalities such as in schizophrenia, the antipsychotic medication is of primary use, at higher dose, with the anxiolytic and mood stabilizer medications of secondary use, at lower doses. For major mood abnormalities such as bipolar disorders, the mood stabilizer medication is of primary use, at higher dose, with the anxiolytic and antipsychotic medications of secondary use, at lower doses. For major anxiety abnormalities such as post-traumatic stress disorder, the anxiolytic medication is of primary use, at higher dose, with the mood stabilizer and antipsychotic medications of secondary use, at lower doses. Finally, severely ill complex patients, with major abnormalities in all three dimensions, may require higher doses of all three classes of medications.

In a whole-body perspective (Table 1), for cancer for example, a 3D treatment will involve medications that reduce carcinogenesis, stop cell proliferation, and inhibit metastasis.

Besides the right treatment, the right dose and the right time are important. Similar to the three evolutionary principles of age, quantity and environmental fit, a successful treatment would start early, at high enough doses of the right fit of medications to stop the illness completely before it develops further, nipping it in the bud. This approach is obvious in its merits for cancer treatment, but in fact should be pursued for all illnesses, including psychiatric illnesses.

FES/HES ratio can be increased through cognitive therapies, diet, and other environmental choices. A positive and favorable environment can mitigate internal abnormalities. Environmental toxins (including negative interpersonal relationships) may be as detrimental as internal (genetically inherited) abnormalities. However, an internally resilient individual can survive and thrive despite, or perhaps because of, adverse environmental conditions.

8.4. Mindscape addictions

Addictions have effects on all three dimensions of Mindscape. They may have rewarding effects at lower doses and aversive effects at higher doses. The dose threshold for their impact—rewarding or aversive—on each dimension is different for different addictions, and for different individuals depending on their genetic make-up. For example, alcohol has effects on all three dimensions of Mindscape. At a certain dose, in different individuals, alcohol can impact anxiety primarily, mood primarily or cognition primarily. As such, some individuals primarily drink to be calm, others to be happy, and others, respectively, to be drunk/become dissociated from reality (Rodd et al., 2007).

The learning and memory mechanisms involved in addiction may provide an opportunity for therapeutic intervention and pattern interruption using exposure to HES, whether deliberately in a clinical setting or spontaneously in a naturalistic setting ("hitting rock bottom").

Taken together, these distinctions may help with understanding the impact of addictions on Mindscape and ultimately Lifescape, and for the implementation of individualized therapeutic measures. On the positive side, achieving life goals, and the happiness and reward triggered by such events, can become a constructive addiction. As such, individuals with addictive propensities in their Mindscape can in fact become some of the most successful individuals, by sublimating their weakness into a strength.

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Conflict of interest

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