Evolution-based Approach to Understand and Classify Mental Disorders

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Abstract

Context: The present diagnostic manuals for mental disorders (DSM-5 and ICD-10) rely primarily on traditional descriptive phenomenology; the use of objective, biological criteria (such as neurological or genetic correlates) has limited impact. Considering the human brain as a "box of tools" designed by the process of evolution offers an alternative framework. There are two main reasons for classifying a particular brain condition as a mental disorder: It entails either an unwarranted reduction in quality of life, or problems with functioning in society. In either case, the condition tends to have a correlate in the form of brain functions not operating according to the "intent" laid down in the evolutionary design.

Objective: The present text reviews the evolutionary perspective on mental health and suggests features that may contribute to a novel nosology. The approach is based on an inventory of the various functions, or modules, evolution added to the brain for the purpose of survival and procreation. It focuses on major categories of disorders (that is, meta-structure), but combined they should accommodate presently recognized conditions.

Conclusion: The evolutionary perspective offers insight that may inform diagnostics, or at least improve our conceptual grasp of mental conditions.

Keywords: Nosology; Evolution; Brain modules; Neurology, Mental disorders; Diagnostics

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Introduction

An evolutionary perspective implies to understand the present features of an organism in light of the process that shaped these features. As famously pointed out by the biologist Theodosius Dobzhansky, "Nothing in biology makes sense except in the light of evolution." Regarding humans, the psychologist Henry Plotkin [1] notably rephrased the first part of the sentence to "Nothing makes complete sense". Psychopathology should be no exception.

Several scientists have taken advantage of the evolutionary perspective in order to improve our understanding of psychopathology [2-5]. In addition, there is a vast literature using this perspective on specific disorders, primarily conditions such as anxiety and depression for which evolutionary thinking may be particularly instructive. Although the above-mentioned texts try to cover the field of mental health, they tend to follow traditional classifications, rather than providing a complete nosology based on an evolutionary approach.

The present strategy for nosology is based on the modular concept of the brain [6-8]. Brain modules imply that evolution gradually added various functions for the purpose of survival and procreation. Although the functions are not distinct entities, they may still be considered as separate "tools". The various functions, or modules, evolved through an endless implementation of minor modification. Nervous systems have approximately 600 million years of history, while the features arguably required for the concept of mental disorders to make any sense – consciousness and feelings – may date back some 300 million years [9,10].

By exploring the requirements attended to by the nervous system, and the evolutionary trajectory leading to Homo sapiens, we should have a reasonable starting point for describing the various functions our brain is equipped with. As with a car, any part of the brain may malfunction; which in some cases result in mental problems. Unlike the car, the brain's modules are not neatly separated, physical entities, but more likely reflect dispersed and partly overlapping neuronal circuitry. The modules typically work somewhat like apps in a Smartphone; they are

turned on as needs arise, and subsequently turned off when no longer required. Some modules have broad functions, thus straining the concept; for example, our capacity for cognitive deduction may be described as a module, but it is engaged in a variety of situations. To what extent a function is considered a single module, or split into several, is somewhat arbitrary. Humans are genetically a relatively homogenous species [11], but culturally extremely heterogeneous as the brain modules are designed to be moulded by the environment [12]. The genetic homogeneity suggests that the "innate versions" of the brain modules are reasonably similar in all present populations. If so, the vulnerability for associated disorders is shared, but the actual phenotype of the disorders will be influenced by cultural and personal factors – severely complicating the design of diagnostic criteria.

The universal aspect of the modules indicates that they may offer a framework for a coherent nosology, but the effort requires the challenging task of delineating the various modules. It seems worthwhile to pursue this function-based approach, regardless of how useful the strategy eventually will prove to be. The science referred to as evolutionary behavioural ecology deals with how to set up an inventory of brain functions [13]. In the case of humans, the task is particularly difficult. However, as with the car, not all parts of the brain are equally vulnerable – or likely to cause psychological problems when dysfunctioning – thus a complete list of modules is not required. In **Table 1**, I suggest a nosology based on the evolutionary perspective. In the next sections, I consider relevant literature on the topic and discuss some issues related to this approach.

Identifying mental problems

Any psychiatric nosology is necessarily based on ideas as to what constitutes a disorder. Below is a discussion relevant for the present classification.

In biology, the primary measure of success is fitness – which implies the capacity to pass on genes. This is not an appropriate foundation for defining mental health; as it would, for example, mean that rapists display preeminent health, while the use of contraceptives is a major disorder. In other words, a delineation based on cultural values is required.

Problems with the brain typically manifest in two ways: Either there is a reduction of quality of life/well-being/happiness, or the individual does not function well. The latter category may be subdivided into emotional, cognitive, sensoric, or motoric problems. As psychology traditionally focuses on the happiness aspect, as well as on certain forms of functional problems (e.g., psychosis), the former category is the more pertinent. Functional issues can cause mental suffering – losing your hearing may, for example, lead to depression – however, it should be noted that dysfunction and happiness are not inversely related. People with Down syndrome appear to be happier than the average [14], at least in a society where they are cared for; while a depressed person may function reasonably well.

A focus on happiness may seem to miss a variety of impairments, such as a reckless attitude to life, or an inability to function socially. It should be pointed out that most functional problems

will be included in a definition of mental health that focus on well-being, if one considers both short- and long-term happiness, and include both the individual and the remaining population. Even if the impairment does not immediately reduce the well-being of a particular person, it may have a long-term impact on his/her somatic health, which is likely to cause agony; or it may be a stress factor for society. The stress on society may manifest in the form of aggression, such as with sociopaths, which is expected to reduce the well-being of others; or it might be a matter of an economic burden. The latter could reflect expensive treatment, life in an institution, or an inability to contribute a fair share to the community. Thus, the well-being of the population may be considered a core criteria for mental health; as well as for the progress of society [15].

With a focus on well-being as the prime feature of psychopathology, it is important to note that distress is only pathological if inappropriate or in excess. The lack of capacity to feel fear [16], or physical pain [17], is pathologic; proper forms of agony are not. In short, the narrative of the individual patient, as to the type and extent of suffering, forms key information for diagnostics. Ideally, one should have a clear delineation of what constitutes "normal" distress. In the absence of a reasonable norm, it seems unavoidable that the same level of suffering will be considered pathologic by some, but not others.

There is considerable variation between individuals as to the output, in the form of conscious experiences, that stem from the various modules. That is, each module can manifest itself with various vigour, and in somewhat different ways, reflecting both cultural and personal peculiarities. The individual-based distribution of manifestations may adhere to a Bell curve, or dysfunctional states may form "shoulders" on the graph. In any case, for practical purposes the diagnostic definition of a disorder will reflect somewhat arbitrary "cut-offs" (considering both severity and duration of symptoms) as to how far from the accepted range a particular manifestation is. On the "healthy side" of the cut-off, the condition may still have a negative impact on well-being. The actual cut-off, and the details of manifestations considered relevant, depend on cultural variables; what is considered dysfunctional in one country may be normal elsewhere [18].

A related issue is whether there exist distinct categories of mental illness, as opposed to describing the various conditions as a continuous spectrum along one (or a few) dimensions [19]. The present approach opts for categories in the form of malfunction of particular modules. Obviously, the various modules depend on, and interact, with each other; dealing with them as separate entities is therefore a question of convenience.

Causes of mental problems

In the present terminology, psychopathology typically implies a dysfunctional module that causes distress either in the patient or, directly or indirectly, in others. Some modules are particularly vulnerable (e.g., fear and low mood), while others are unlikely to be associated with mental problems (e.g., those controlling movement of toes or the taste of bitterness).

Nosology tends to distinguish between Mental and behavioural disorders (Chapter V in ICD-10), and Diseases of the nervous

system (Chapter VI). If brain disorders are categorized according to the function involved, this distinction is not obvious. Dysfunction, and thus psychiatric symptoms, can be due to a range of what may be referred to as "organic" conditions, including stroke, traumas, tumours, degenerative changes, psychoactive substances, and infections. Clearly, treatment should depend on the cause. In most cases, symptoms rooted in neuropathology can be distinguished from typical psychiatric conditions. The present text outline dysfunctional modules without considering cause, but the focus is on conditions typically associated with psychiatry. This narrows the list of brain inflictions that need to be included.

Psychopathology can be due to either genes or environment, but more often it is a combination of the two. One account, as to why a particular combination can lead to adverse consequences, is that the environment is at odds with what is natural (or preferable) for the human species. Differences between the present conditions and the presumed way of life of our distant ancestors are sometimes referred to as "mismatches", but most mismatches are benevolent. We sleep better on soft mattresses, rather than on damp soil; and we live longer and healthier thanks to antibiotics. The mismatches responsible for pathology may be referred to as "discords" [20]. For example, the typical way of handling infants in Western society may constitute a discord responsible for an elevated prevalence of anxiety disorders [21]. Discords typically cause pathology only in individuals who are vulnerable.

In some patients, psychopathology is associated with particular mutations, as in rare cases of schizophrenia [22]. More often, mental disorders may reflect the sloppy way evolution operates. Evolution does not create optimally adapted organisms, the sole criteria for success is to retain a capacity for survival and procreation. There are dubious aspects of the anatomical design of humans (such as the spine and the appendix); one would expect similar unsavoury features when it comes to the brain. Another quandary of evolution is that most features, whether anatomical or mental, are meant to display a range of phenotypes. Without (genetic) variation, evolution would not be in a position to improve the constitution of the species and thus avoid extinction. Extreme phenotypes (e.g., a very low stature or a particularly strong propensity for fear) may be considered pathological even when there are no obvious defects in either genes or environment. Moreover, certain genes may carry a risk for pathology because the particular alleles bring other advantages, a situation referred to as balancing selection.

Biological correlates as diagnostic tools

The current Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and the Mental and Behavioural Disorders chapter of the International Classification of Disease (ICD-10) rely primarily on clinical observation and patients' phenomenological symptom reports. There has been a strong drive to obtain more reliable diagnostic tools. The primary concern is to find biomarkers related to genetics, neuroimaging, and metabolics/chemical signatures; or to describe distinct, observable behaviour. The effort has led to the Research Domain Criteria (RDoC) project [23]. Unfortunately, so far the biomarker approach has proven difficult. The question,

to be discussed below, is to what extent biomarkers are likely to offer the desired tools. If so, an evolution-based approach may be less relevant; except, perhaps, to help guide the biomarker effort.

There is considerable information available as to anatomical structures and neurotransmitters involved in conditions such as anxiety, depression, and chronic pain [24,25]; however, even with this knowledge, it has proven difficult to find correlates useful for diagnostic purposes. For any module associated with conscious experiences to play out its role in the brain, an array of neuronal circuits are presumably required. After all, consciousness appears to employ a substantial portion of the forebrain [26]. Dysfunction may therefore be due to disruption outside of known key neurological structures. In short, neurological data have so far not delivered as tools that define mental disorders. Advances in this field are expected, but they seem unlikely to solve the problems of diagnostics in the near future.

As to a classification based on genetic correlates, present knowledge suggests that in most cases this approach will have limited value. Genome-wide association studies have led to the discovery of abundant markers, or alleles, that correlate with particular conditions [27]. However, individual (or aggregate) correlates explain only a small part of the heredity. In the majority of cases, the genetic predisposition is probably due to particular constellations of a large number of alleles. This is to be expected, as the working of the brain reflects a complex interplay of a multitude of genes. In fact, the brain appears to be an organ with a particularly varied gene expression profile; more than half of the 20 000 protein-encoding genes are active [28]. Minor alteration in this multifactorial environment, due to particular constellations of alleles, may create vulnerability for various types of dysfunction. Moreover, even in the case of disorders with a relatively high degree of heritability, environmental factors still play an important role. In short, genetic markers seem unlikely to solve the problems facing psychiatric nosology.

Chemical markers, for instance in the form of specific proteins, hormones, metabolic products, or neurotransmitters, have proven useful for certain purposes [29], but again they cannot be expected to offer a basis for a general diagnostics. For the time being, the evolutionary approach may be the option with the more objective framework.

Key modules

It is difficult to set up an inventory of brain modules, as the brain caters to a range of more or less indistinct functions. On the other hand, the indistinct borderlines between functions imply that they can be portrayed in several ways. The present text attempts to distinguish modules based on what seems most applicable for the purpose of psychological nosology. The more pertinent modules are discussed below.

A considerable fraction of mental problems is associated with modules designed to generate negative feelings. The point follows from the focus on well-being when describing psychopathology – that is, people primarily seek help due to mental suffering. In the present terminology, the mood modules are responsible for both positive (rewarding) and negative (punishing) feelings [15]. The

typical patient suffers from unwarranted activity in modules that activate the brain's capacity for punishing feelings, particularly in the form of anxiety, depression, and chronic pain. As discussed elsewhere [24,30], there appear to be key neural circuits that generate negative or positive sensations regardless of the cause (or "flavour") of these sensations. For example, experiencing envy of another person's success activates pain-related circuitry, whereas experiencing delight at someone else's misfortune activates reward-related circuits [31].

It seems reasonable to describe the actual emotions – such as fear, love, or hate – as one set of modules; and the rewarding or punishing sensations they evoke as due to activity in three separate modules. The latter includes one punishment module and two (seeking and liking/consuming) reward modules [15,24,30]. A particular emotion-module may activate either rewards or punishment. Fear, for example, is considered pleasant for a climber experiencing an adrenalin kick; and grief is enjoyable in some situations [32].

It is important to have a terminology that distinguishes between the actual module (or function) and the pathological condition. For example, "fear" is here taken to mean a normal function, while "anxiety" reflects a form of malfunction, or dysregulation, of the fear module. Similarly, depression reflects hyperactivity in the low mood module. A disorder can be due to either hyperactivity (as in the case of anxiety), hypoactivity (for instance anhedonia in relation to the reward module), or simply aberrant activity (as exemplified by psychosis). Psychology tends to focus primarily on one of these options in relation to a particular module. Some people experience hypoactivity of the fear module; that is, they lack the capacity to experience fear from external threats [16]. The condition is apparently due to neurological damage to the amygdala, and may not be considered a mental disorder, partly because it does not necessarily affect quality of life, and partly because it may not benefit from the curative tools of psychology.

The more common form of emotional suffering rests with the emotion modules set up to activate the punishment module. For example, in the case of anxiety, it seems likely that the fear module is overactive, rather than the primary fault resting with the actual punishment circuits. This distinction, however, is generally difficult to make; and it may not matter in terms of (present) treatment options.

Most, if not all, mental conditions involve conscious experiences. It seems reasonable to picture any moment of consciousness as a combination of contributions from a variety of (subconscious) modules; for example, in the form of vision, smell, fear, punishing sensations, and thoughts [10,33]. This implies that the mental defect may rest with either the contributing module, or the circuits of the brain required to bring the information to awareness (the consciousness generating modules). The various contributing modules are assumed to "compete" for access; which means there is a limit to the amount of information that can form a moment of experience. If one module is overly active, other modules are supposedly less likely to score in this competition. When modules that deliver punishing sensations (including fear and low mood) display excessive activity, the person suffers. The suffering is partly due to the excess of negative feelings, partly to the lack of rewarding sensations.

In some forms of psychopathology, the problem appears to rest with the consciousness generating modules. Schizophrenia is a likely example. Other patients have problems with the modules that turn consciousness on or off, such as in the case of insomnia and narcolepsy. To the extent that mental problems require awareness, any condition can theoretically be due to troubles with the consciousness generating machinery; but in most cases one may at least have an educated guess as to how the condition is best described.

The more common complaints involve inappropriate activation of negative feelings. Excessive positive experiences are rarely a problem; although one may argue that the manic phase of bipolar disorder [5], and perhaps certain forms of recklessness, reflect undesirable hyperactivity of reward circuits. Modules responsible for negative feelings are there to protect the individual, which in general is a more important function (for the genes) compared to instigating behaviour by activating rewards. Consequently, the brain more readily dishes out pains compared to pleasures. In short, the pain related modules are both more likely to become hyperactive, and more likely to form the basis of complaints [10] for a more elaborate discussion).

A malfunctioning brain may be due to the dysregulation of several modules, which is reflected in the concept of comorbidity. The point is highly relevant in diseases that cause gross malfunctioning of the brain, such as dementia and neurodevelopmental disorders; but is also the case when different modules become aberrant for related reasons, as may be the case with the common comorbidity of anxiety and depression. The diagnose may attempt either to list all affected modules, or to focus on those that appear to be primary, and/or those considered more pertinent or treatable. Furthermore, a problem in one function often manifests itself by causing maladaptive behavior associated with other functions. For example, anxiety can manifest as an eating disorder; and depression can manifest as an addiction. Conversely, a particular type of symptoms may be due to problems related to different modules; hallucination could be related to faults in the primary visual cortex, or to faults further up in the generation of conscious percepts. An evolution-based nosology can, perhaps, alleviate some of the above-mentioned diagnostic quandaries, but will not resolve them.

Specific comments to the proposed nosology

Table 1 offers an outline for an evolution-based approach. It is meant as a draft, designed to reflect a way of thinking. It focuses on a set of categories and key modules for each category.

The Basic survival functions have obvious evolutionary relevance; however, although the associated disorders involve these functions, they may also relate to other modules. Anorexia, for example, may be related to anxiety or depression. Similar comments are relevant for other categories as well. Habit formation is listed under basic functions. The tendency to develop habits was presumably added by evolution because it is useful to have easily instigated behavioural patterns in cases where previous experiences suggest a desirable result (in the form of activation of reward modules). Habits possibly evolved from fixed action patterns, but contrary to the fixed patterns, they allow the conscious brain to impact on decisions. The habit module is

Table 1 Draft for an evolution-based nosology of mental disorders.

Categories	Modules	Explanation/normal function	Main problem/disorder	Subtypes/examples
Basic survival functions	Ingestion	Obtain nourishment and water	Eating disorders	Anorexia, bulimia, binge eating
	External senses	Gathering information about the environment	Various neurological defects causing problems with sensory processing	Akinetopsia, prosopagnosia, achromatopsia
	Motoric	Control of voluntary muscle activity	Motor disorders (lacking or inappropriate contraction of muscles)	Dyskinesia, catatonia, akathisia
	Habit formation	Translates "successful" choices into behavioural patterns	Obsessive-compulsive disorders and addictions	Intrusive thoughts, pathological gambling, kleptomania, misuse of psychoactive substances
Procreation	Sexual behaviour	Passing on genes	Male and female sexual dysfunctions and gender identity issues	Interest/arousal disorder, paraphilic disorders (misdirected or excessive sexual drive)
	Pair bonding	Behaviour meant to secure a partner for procreation and care of infants	Problems related to falling in love, and engaging in a relationship	Excessive jealousy
	Pregnancy and infant care	Caregiving and attachment between parents and child	Lack of bonding and/or lack of proper care	Tocophobia, postpartum depression/psychosis
Social life	Attachment	Infants need to bond with parents, problems have consequences for later relations	Attachment can be either inhibited or too disinhibited	Reactive attachment disorder, oppositional defiant disorder
	Relating to others	Interacting and building bonds with other individuals	Autism spectrum disorder	Autism, Asperger syndrome, extreme introversion
	Compassion	Building social network and trust	Conduct disorders	Sociopathy, sadistic personality disorder
	Anger	Ensure the interest of the individual or his/her group	Excessive use of violence, problems with impulse-control	Rage, related conduct disorders
	Hierarchy formation (status)	Attaining a high status in order to harvest accompanying advantages (mates and resources)	Aberrant dominance or submission	Low self-esteem, narcissism, histrionic personality disorder
	Language	Communication	Communication disorders	Stuttering, speech sound disorder, dyslexia
Negative affect	Fear (external causes)	Avoid danger, fight-or-flight response	Anxiety	General anxiety, phobias, stress, posttraumatic stress disorder
	Fear (internal causes)	Retain homeostasis, different neuroanatomy compared to external fear	Panic or fear associated with, e.g., suffocation	Panic disorder
	Low mood	Learn from mistakes, particularly in social context	Suffering from a low mood	Major depression, loneliness, melancholy
	Grief	Related to low mood, meant to help the person avoid similar situations in the future, but also to signal need of support	Pathological when clearly excessive (or lacking) in a way that is harmful to the person	Prolonged grief disorder
	Pain	Avoid physical harm	Chronic or otherwise maladaptive pain	Phantom pain, any non-functional pain, somatic symptom disorder
Positive affect	Brain rewards	Instigate "approach-and-consume" behaviour	Hyperactivity usually not a problem (with exceptions such as mania), while hypoactivity implies unhappiness	Mania, reckless behaviour, anhedonia
Control of consciousness	Arousal	Ensure attention when needed	Problems related to mental exhaustion	Fatigue, chronic fatigue syndrome, neurasthenia
	Sleep	Retain circadian rhythms	Sleep-wake disorders	Insomnia, hypersomnolence, narcolepsy
	Attention	The capacity for "top down" control of conscious focus	Problems of concentrating, or focusing, on an issue	Attention deficit disorder (and ADHD), delirium

Categories	Modules	Explanation/normal function	Main problem/disorder	Subtypes/examples
Generating conscious experience	Moulding of conscious content and transfer to awareness	Creating an appropriate representation of reality	Psychotic and delusional disorders	Schizophrenia, acute and transient psychotic disorders, paranoia, hypochondria, bipolar disorder, alexithymia,
	Memory retrieval	Making use of acquired explicit memory	Loss of memory as well as storage and retrieval problems	Alzheimer's disease and other forms of dementia, amnesia, hyperthymesia
	Self-perception	Distinguishing self from external objects, create agency	Problems sensing oneself as a distinct person with relevant qualities	Dissociative identity disorder, trance and possession disorders, depersonalization disorder, anosognosia
Cognitive capacity	Cognition	Required for planning and other intellectual pursuits, including problem solving and abstract thinking	Intellectual disability or suboptimal cognitive functioning	Down's syndrome, dementia
Others	Problems related either to unknown modules, or to several modules and thus difficult to characterize. The category may not be needed.			

particularly vulnerable in an environment with abundant reward stimuli that, if consumed regularly, have undesirable long-term effects.

Procreation is a key assignment for the genes. Sexual behaviour consequently involve powerful emotional and behavioural propensities. The task is complicated by the fact that it requires collaboration between individuals with only partly shared agendas. It should not come as a surprise that the relevant modules are easily distorted. The question is not whether the behaviour is biologically sensible, but whether it causes distress for those involved. Cultural values are important factors because they set the rules for what is considered appropriate. The rules are relevant for mental health when they lead to agony in people whose behaviour is not in line with expectations.

Humans evolved as a highly communal species, implying that the modules involved in Social life are of considerable importance. Unfortunately, social relations appear to be an "Achilles heel" in modern society [34]. Consequently, it is an important topic for psychopathology. Social affairs are generally orchestrated by emotions; thus the modules included in this category, tend to be closely affiliated with the mood modules. Relationships are particularly relevant in connection with anxiety and depression, which means that it can be difficult to decide whether a particular problem should be listed under Social life or Negative affect. Collaboration depends on bonding between individuals, which is instigated by the use of positive feelings; compassion is used as a collective term for these feelings. It can be construed as a form of "love", but employed in circumstances where procreation is not the primary purpose of bonding.

The two categories Negative and Positive affect include what I have referred to as mood modules. **Table 1** does not distinguish between the instigating (emotional) module and the three modules actually responsible for the pleasure and pain. It is assumed that in most mental disorders, the problem rests with the emotional part (or the two cannot be distinguished).

Excessive fear is a common cause of psychopathology. **Table 1** differentiates between external (most cases) and internal causes, as the two appear to have a different neurology [16]. The former is based on what the external senses tell about the environment, why the latter reflects homeostatic control mechanisms. Panic disorder is tentatively associated with the latter, suggesting that this term might be restricted to cases related to internal issues, such as a feeling of suffocation.

The importance of maintaining a social network is presumably a main instigator of low mood (as in loneliness), but the module is relevant in any situation where a person performs sub-optimally as measured by expectations. In the Stone Age, it could mean an unsuccessful hunt; today, flunking an exam. The primary function of the module is to instigate a change of tactic, or other measures, in order to avoid repeating the failure. Grief typically entails a level of low mood, but serve additional purposes. Grief presumably helps the individual overcome a loss, and it may elicit help from others. In other words, it can be punishing in order to "teach the person a lesson"; but also rewarding [32], as instigating this emotion (and its concomitant display) serve a purpose.

Pain is a key module as to quality of life. Chronic pain, which implies inappropriate activity of this module, afflicts perhaps 20% of the population [35]; but the problem is typically not regarded as psychological. In an evolutionary perspective, pain is meant to go away when no longer required to guide behavior. Consequently, even pain with a physical correlate, such as rheumatic pain, may be considered inappropriate (and thus pathologic) when chronic.

The Generating conscious experience category is problematic, as it is particularly difficult to know whether a quandary rests with this category, or with the modules delivering conscious content. As to the module responsible for "creating an appropriate representations of reality", it should be noted that appropriate here does not necessarily mean correct. The brain introduces a range of biases when processing either external or internal

information. "Not appropriate" thus implies aberrations beyond normal biases, or aberrations that lead to psychopathology. Bipolar disorder relates to the mood modules, but may be listed here as it appears (at least in some cases) to reflect a disturbance in how these modules generate conscious content.

Cognitive capacity is another problematic category that overlaps with the above category. Typical problems, such as dementia or being retarded, are not necessarily referred to mental therapy.

An Others category is added for conditions not easily placed elsewhere. Ideally, this category should be obsolete, but it is practical for "short term storage" of problematic disorders.

Conclusion

A complete, evolution-based nosology is feasible, but perhaps not practical. The approach is worth further considerations, but any classification will necessarily be a compromise, as the brain was not designed for the human desire to classify.

The present approach may be more relevant as a paradigm, or template, that can be used to organize information pertaining to mental disorders. It seems likely that by defining functions (and thus malfunctions) according to an evolutionary perspective, we gain insight into mental issues. Evolutionary thinking does not solve the need for appropriate diagnostic criteria, but it may guide the search.

References

1. Plotkin H (1997) Ax in Mind.Allen Lane, New York.

2. Nesse RM, Stein DJ (2012) Towards a genuinely medical model for psychiatric nosology. BMC Med 10: 15.

3. Stevens A, Price J (2016) Evolutionary Psychiatry. Classic Edtn. Routledge, London.

4. Brûne M (2015) Textbook of Evolutionary Psychiatry and Psychosomatic Medicine. The origins of psychopathology.2 nd edtn. Germany.

5. Nesse RM, Jackson ED (2006) Evolution: Psychiatric nosology's missing biological foundation. Clinical Neuropsychaitry 3: 121-131.

6. Carruthers P, Chamberlain A (2000) Evolution and the Human Mind. Cambridge University Press, Cambridge.

7. Sporns O, Betzel RF (2016) Modular Brain Networks. Annual Review of Psychology 67: 613-640.

8. Barrett HC, Kurzban R (2006) Modularity in cognition: Framing the debate. Psychol Rev 113: 628-647.

9. Grinde B (2013) The evolutionary rationale for consciousness. Biological Theory 7: 227-36.

10. Grinde B (2016) The Evolution of Consciousenss.Springer. Switzerland.

11. Kaessmann H, Victor W, Gunter W, Paabo S. (2001) Great ape DNA sequences reveal a reduced diversity and an expansion in humans. Nat Genet 27: 155-156.

12. Pagel M, Mace R (2004) The cultural wealth of nations. Nature 428: 275-278.

13. Westneat DF, Fox CW (2010) Evolutionary Behavioral Ecology. Oxford University Press. New York.

14. Robinson R (2000) Learning about happiness from persons with Down syndrome: Feeling the sense of joy and contentment. Am J Mental Retard 105: 372-376.

15. Grinde B (2012) The biology of happiness. Springer, Dordrecht, Netherlands.

16. Feinstein JS, Colin B, Rene H, et al. (2013) Fear and panic in humans with bilateral amygdala damage. Nat Neurosci 16: 270-272.

17. Cox JJ, Reimann F, Nicholas AK, Robin L. Follmer,3 Nader Dahdalehet al. (2006) An SCN9A channelopathy causes congenital inability to experience pain. Nature 444: 894-898.

18. Wakefield JC (2007) The concept of mental disorder: Diagnostic implications of the harmful dysfunction analysis. World Psychiatry 6: 149-156.

19. Adam D (2013) Mental health: On the spectrum. Nature 496: 416-418.

20. B (2009) Can the concept of discords help us find the causes of mental diseases? Med Hypotheses 73: 106-109.

21. Grinde B (2005) An approach to the prevention of anxiety-related disorders based on evolutionary medicine. Preventive Medicine 40: 904-909.

22. Fromer M, Pocklington AJ, Kavanagh DH, Williams HJ, Dwyer S et al. (2014) De novo mutations in schizophrenia implicate synaptic networks. Nature 506: 179-184.

23. Cuthbert BN (2014) Translating intermediate phenotypes to psychopathology: The NIMH Research Domain Criteria. Psychophysiology 51: 1205-1206.

24. Leknes S, Tracey I (2008) A common neurobiology for pain and pleasure. Nat Rev Neurosci 9: 314-320.

25. Willner P, Scheel-Kruger J, Belzung C (2013) The neurobiology of depression and antidepressant action. Neurosci Biobehav Rev 37: 2331-2371.

26. Dehaene S (2014) Consciousness and the brain: deciphering how the brain codes our thoughts. Viking , New York.

27. Geschwind DH and Flint J (2015) Genetics and genomics of psychiatric disease. Science. 349: 1489-1494.

28. Sjostedt E, Linn F, Bjorn M, Häggmark A, Mitsios N, et al. (2015) Defining the Human Brain Proteome Using Transcriptomics and Antibody-Based Profiling with a Focus on the Cerebral Cortex. PLoS One 10: 1-20.

29. Sokolowska I, Ngounou Wetie AG, Wormwood K, Thome J, Darie CC (2015) The potential of biomarkers in psychiatry: focus on proteomics. J Neural Transm (Vienna) 122: 9-18.

30. Kringelbach ML ,Berridge KC (2009) Towards a functional neuroanatomy of pleasure and happiness. Trends Cogn Sci 13: 479-487.

31. Takahashi H, Kato M, Matsuura M, Dean Mobbs , Tetsuya Suhara,et al. (2009) When your gain is my pain and your pain is my gain: neural correlates of envy and schadenfreude. Science; 323: 937-939.

32. O'Connor MF, Wellisch DK, Stanton AL, Eisenberger NI, Irwin MR, et al. (2008) Craving love? Enduring grief activates brain's reward center. Neuroimage 42: 969-972.

33. Koch C, Massimini M, Boly M, Tononi G. (2016) Neural correlates of consciousness: progress and problems. Nat Rev Neurosci 17: 307-321.

34. Grinde B (2000) Social behavior: Making the best of the human condition. Mankind Quarterly 41: 193-210.

35. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D (2006) Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. Eur J Pain 10: 287-333.