

Quantum neurobiological view to mental health problems and biological psychiatry

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Without exception, what we call schizophrenia is a strategy devised to live in a situation where life is unlivable. Mystics and schizophrenics are in the same ocean, but where mystics float, schizophrenics sink... Madness need not always be understood as a collapse of personality. It can also be thought of as a great step forward. As much as captivity and existential death, it can carry the seeds of liberation and rebirth...

Ronald D. Laing
(1927-1989) Psychiatrist

Summary

Psychopathology is the state of the normality of daily life being affected by a deviation from what is considered normal. The most important of these are measurements of statistical deviation from normal, disruption in coping with social relationships, disruption in the perception of reality, and sleeplessness. Their importance is not in that they occur sporadically or rarely, but in their persistence and the diagnosis of psychopathology. With this approach, more average behavior is accepted as ideal. With a more systematized diagnosis, a psychiatric condition, in order to be called pathological, must show deviance from the ideals of feeling, emotion and behavior, it must be related to negative feelings, it must disrupt daily functions, and it must constitute a danger to the persons themselves or to those around them. In the biological approach, psychopathologies are reduced to neurons, neural nets, synaptic pathologies and neurotransmitters. However, the basis of psychopathologies can today also be demonstrated at much deeper levels. When these deep structures are considered, a new viewpoint emerges, which can be called super reductionism or a quantum psychopathological approach. In this article, information on quantum psychopathology, which is still in its infancy, will be reviewed, and psychopathologies will be considered with the somewhat speculative quantum physical approach.

Key words

Psychopathology • Quantum physics • Psychiatric diseases • Mood disorders • Schizophrenia

Introduction

Engel proposed the bio-psycho-social model of psychopathology starting from classical physical analogies¹. The popularity of this idea slowly grew and became more established when the theory of nerve cell nets came to prominence. According to this, abnormal communication between nerve cells in the brain are the cause of psychiatric illness. For example, Hoffman connected schizophrenia in this way to a parasitic attractors². Hoffman's paper marks beginning of the neural modelling of schizophrenia. Some other researchers have connected indirect brain dynamics with the nerve cell nets theory and, connecting it to the excessive effects of dopamine, have proposed a model to explain schizophrenia³. In this way, each synaptic connection causes a chemical disruption, and schizophrenia is reduced to an increase in dopamine or a reduction in glutamate in spe-

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cific areas of the brain. However, this clinical picture, reduced to nerve communications, does not improve in all directions and in all patients ⁴. In fact, it is unclear whether the proposed synaptic imbalance is an epiphenomenon of the clinical picture or whether it is the cause of the illness ⁵. However, the diagnosis of psychopathology is different from the viewpoint of psychodynamic, behavioral and cognitive psychology. Whereas from a psychodynamic point of view subconscious conflicts form between basic desires and limitations (libidinal balance and hydraulics), from the point of view of behaviorism, certain formal behaviors come about as a result of reinforcement and penalization. From the point of view of cognitive psychology, negative beliefs about individuals themselves and others and the outside world lead to negative behavior and feelings.

So far until today, the disease model valid for psychiatric illnesses has been reduced to the basis of a disruption in brain chemistry. From this chemical disruption emerge disruptions to differing extents in feelings, thoughts and behaviors. It is accepted that with a trend arising for genetic reasons, added to environmental reasons, illness caused by vulnerability in a person brings out the clinical phenotype. Another model of the appearance of illness is the diathesis-stress model, according to which illness occurs when a threshold is passed and a pressure system breaks down.

Quantum psychiatry and psychopathology: a short history

The term quantum psychopathology (QPP) was first used by Donald Mender, of Yale University. In June 2008 he planned an international meeting under the name of *Quantum Paradigms of Psychopathology*, and recommended discussion on whether quantum physics and brain theories provided a new viewpoint on psychiatric illnesses such as schizophrenia, bipolar disorder or hallucination, and the possible relation to psychopathologies. Later, following the Fano (Italy) conference in March 2012, and the third *Quantum Paradigms of Psychopathology* meeting in Palermo, in Sicily, Italy in April 2013, and the Palermo Declaration was published. New scholarly papers opening up fresh perspectives on the potentially key role of quantum neurodynamics in mental illness have been generated in the wake of interchanges in Fano (Italy). All these developments herald a bright future for the QPP initiative. On April 27, 2013 a core international group of investigators, offering expertise in the fields of psychiatry, biochemistry, physics, computational neuroscience, mathematics, philosophy and theology, gathered in Palermo, Sicily under the auspices of the global QPP initiative with the aim of assessing the potential relevance of quantum physics and quan-

tum chemistry to the mapping of mind-brain relations in normal and abnormal states of consciousness applicable to humans and non-human animals. Positions taken by members of the Palermo Group have argued that ⁶: recent progress of a restricted kind in mainstream consciousness research has proceeded rapidly due to dramatic technical improvements in relevant empirical research tools. Classical biophysics, which provides the paradigmatic foundation of mainstream consciousness research, has offered bountiful correlations between subjective reports of qualitative human experience and quantitative measurements of objective physical processes. However, these merely correlative advances have not at all addressed what David Chalmers has termed the “Hard Problem” of mind-brain relations by bridging what Joseph Levine has called the “Explanatory Gap” between qualitatively subjective phenomenal experience and quantifiably objective physical events ⁷. So far no explanatory bridge between consciousness and corporeal neural tissue has issued from the classical biophysics of mind and brain in *Homo sapiens*, and, in research on non-human subjects precluding self-reports via human language abilities, even correlations have remained substantially elusive ⁸. Quantum approaches may offer greater latitude in addressing these classical deficiencies, to the extent that at least some latent links formally exist between the qualitative dimensionality and quantitative measurability of canonically conjugate quantum observables, whereas no such formal links are required with reference to the possessed observables of classical physics ⁹. Moreover, at least one interpretation of quantum measurement as formulated by John Von Neumann casts the measuring agency itself as subjectively conscious per se, in contrast to an absence of any such classical notion ¹⁰.

Quantum generalization of classical biophysics opens up the possibility that relevant brain processes may reach both beneath the scale and beyond the boundaries of discrete neurons separated by synaptic clefts. Quantum-germane structures and dynamics within the brain may include superposed dimeric tubulin conformations in the microtubular cytoskeleton spanning both intraneuronal and interneuronal spaces, ordered water in relation to cytoskeletal proteins, membrane channels and lipids together with their second messenger pipe lines to neuronal interstices, and solitons communicating along cytoskeletal routes between classical and quantum aspects of brain function. Max Tegmark's objections ¹¹ to the thermodynamic feasibility of such quantum structures and processes surviving thermal decoherence at biological temperatures entailing orders of magnitude comparable to those within the human skull have been thrown into doubt by the recent work which has demonstrated non-trivial quantum com-

putation in photosynthesis. The ubiquity of water, cytoskeletal tubulin, membrane lipids, and second messengers in non-human life suggests that a new biophysics, accounting for quantum-generalized processes in living tissue, may lead to future predictions about consciousness not only in human beings but also in organisms lacking any semblance of human brain architecture at the level of organized neuronal networks or “higher”¹². The quantum wetware outlined above is more compatible with these formalistic findings than is any classical model of neural biophysics. Both quantum-logical and quantum-physical cartographies of mind and brain also promise to generate avenues for improved comprehension of neurophysics in psychopathology. Explanatory and even psychotherapeutic opportunities may emerge from considerations of superpositional logic and malattunement in primary process thinking by schizophrenic patients, of Everett’s quantum ontology in the “alternate/many worlds” of psychotic perception, and of membrane and second-messenger interfaces between serotonin biochemistry and quantum-microtubular nanowire dysfunction in mood disorders. Aberrations of scale-dependent emergence in quantum thermofield phase transitions and problematic barriers to Bohmian holism may be important in multiple forms of mental illness. *We declare the following:*

Even the absence of highly complex synaptic connections among neurons does not preclude the presence of at least rudimentary phenomenal experience in organisms endowed with superposed microtubular dimers, ordered water, membrane ion channels, and/or crucial lipid raft assemblies connected to selected second messenger systems. In addition, quantum-biophysical aspects of these and/or other yet unmapped structures and related processes may prove to be potent factors in the deeper etiologies and improved treatments of psychiatric disorders.

This is the official history, but in fact an inquiry article had been published in 2000, before a name had been given to the subject¹³. Articles continue to be published considering topics such as depression, schizophrenia, bipolar disorder, hallucination, anorexia nervosa and decision-making disorders with a quantum psychopathology approach.

Why quantum psychopathology?

Until today, the brain pathology of all psychiatric illnesses has been reduced by the trend towards biological psychiatry to networks between nerve cells, to nerve cells and to synaptic imbalances in the communication between cells. However, if this is so, the end-point of nerve networks and inter-cell communication and relations is not synapses but may extend to ion canals, ions, electrons and even to a quantum field giving temporary

forms to subatomic particles. Looked at this way, even if quantum psychopathology is regarded as super-reductionism, when quantum field theory and quantum physics are considered, this type of reductionism can lead to a more holistic point of view¹⁴. Another aspect is that quantum physics with its one-century history is relatively new compared to the three centuries of classical physics. This new quality brings a new language with it, and this has had a jarring effect on classical ways of thought. It is forcing us to change from the language and thought patterns to which we are accustomed to new forms. For example, the binary system of 0 and 1 which we have always used in the decision processes of classical physics has given way to the quantum bit or Qbit, as also in computer processing and symbolic logic, and we have found that the choices are not only between 0 and 1, but 0, 1 and both 0 and 1 at the same time. This quantum bit is known as a Qbit, and is represented as $|0\rangle$, $|1\rangle$. Unlike the classical bit or C-bit, which takes the value 0 or 1, the Qbit can take other states in addition to these two classical states – the states of $|0\rangle$, $|1\rangle$, and both differently superposed – that is, it can be in the states of both $|0\rangle$ and $|1\rangle$ at the same time¹⁵.

Thus, Qbits show two basic states: $|0\rangle$ and $|1\rangle$. Classically, they can occur only in one of these two states, but for Qbits the possibilities are infinite. Any state can form a superposition, and the total wave function is $|\psi\rangle = a|0\rangle + b|1\rangle$, and is $|a|^2 + |b|^2 = 1$ here. Both a and b are complex numbers. All states of a Qbit carry the structure of two-dimensional Hilbert space. If we measure whether the system is in a state of $|0\rangle$ or $|1\rangle$, the superposition collapses. The state, with probabilities of $|a|^2$ and $|b|^2$, is reduced from the basic states of $|0\rangle$ and $|1\rangle$ to one of them. Therefore, any measurement of $|\psi\rangle$ represents much more than it represents in a classic understanding. Quantum probability is a better model for human cognitive functions than classic Bayesian probability theories. The classic approach is inadequate for many subjective and behavioral states. In particular, the existence of the state of quantum superposition (in addition to the state of 0, 1, the state of 01) can provide new points of view from the angle of cognitive functions. The result of Qbits is still classic.

New analogies both in language and in quantum physics can help us to understand psychiatric illnesses. The understanding that classic physics imposes, that we are observers of everything outside of ourselves, forces us to consider the question of whether we are part of the universe. An example in quantum physics is where unobserved matter behaves as a wave, but when observed displays the behavior of a particle. In this way, quantum physics makes our understanding of the reality of the universe disappear in a puff of smoke. In the 1960s, new particles kept on being discovered; in the

1970s it was understood that these particles were energy or energy fields, and since the 1980s energy is gone and everything has become information. In this process some quantum physicists have openly doubted the reality of the universe, and have shared their ideas in books and articles.

One very strange and amazing term is entanglement. Quantum entanglement is a state in which objects are separate from each other but are still in communication. There is nothing like this in classical physics¹⁶. An observation or measurement which we make of one object independently affects another which may be related to it at a distance. This effect is simultaneous and the communication between them is faster than the speed of light. In general, if the quantum level is thought of as the level of small-scale particles, the concept of small does not in fact indicate a physical dimension. Quantum results have an effect over distances of meters and even light years. This phenomenon has been proven by experiment so that there is no room for argument, and there is not the least doubt of its reality. From the point of view of quantum psychopathology, entanglement may exist not only at the level of subatomic particles but also between brains^{17 18}. That is, people's feelings and thoughts may be affected not only by the network of nerve cells in their own brains but also by a bigger network of brains. This kind of an interaction may help to explain conditions such as hallucinations and thought intrusion which are seen in psychiatric illnesses.

Another concept which was long thought fictional but which has assumed an important place in academic physics publications, the multiple or parallel universes model, has shaken up our understanding of a single reality. When it is thought that there may be a small possibility of communication between the other selves in the universes which are formed whenever a choice is made, just as our viewpoint of "our self alone" will change, so our outlook on its pathologies will change. The model of multiple minds or multiple universes may help to understand "self" disorders and conflicts and indecisive selves.

Another reason for the necessity of quantum psychopathology is that quantum brain theories are becoming better understood and that it can explain higher cognitive functions such as memory, recall, consciousness, decision making and mind content. In the past three decades, quantum brain theories have been increasingly developed, and some of them have now reached the mature stage where they can be tested experimentally or falsified. If in healthy brains higher cognitive functions can be connected to a base of quantum mechanics, a natural consequence of this is that psychopathological conditions must have a place in this normal. That is, it will be a scientific approach which will fit the *zeitgeist*¹⁹.

Quantum brain theories and psychopathology

There are many quantum brain theories which attempt to explain how normal cognitive functions appear in the physical brain. The oldest of these theories are Umezawa's quantum field theory relating to corticons in the brain^{20 21}, quantum brain dynamics developed from this theory by Jibu and Yasue²², and Vitiello's thermofield brain dynamics²³. Another important theory besides this is Walker's quantum synaptic tunneling²⁴. Another theory closely related to this one is Eccles and Beck's dendron-psychon synaptic tunneling, taking place in the dendrons^{25 26}.

Stapp's quantum interactive dualism²⁷ and Bernroider's ion canal entanglement²⁸ are other theories proposed for the functioning of the normal brain. Also, one of the most written-about and discussed theories is the microtubules consciousness theory of Penrose and Hameroff^{29 30}. Even if these theories seem to be separate, looking at the details, it can be seen that they are closely related to one another, and need to be so. For example, Eccles and Beck's synaptic tunneling is not very different from that of Walker, and Eccles' interaction of brain dendrons with psychons, the basic units of consciousness, Bohm's implicate order and Umezawa's corticons are not very different basic concepts. Penrose and Hameroff's microtubular brain theory appears to be basically related to microtubules, and broad field communication between cells in the brain occurs by tunneling in gap junction areas. For Jibu and Yasue's quantum brain dynamics, the areas under the membrane in the microtubule theory is the fundamental area. As will be seen, although quantum brain theories have been proposed by different people at different times, at a basic level all these theories are in some way related to one another. However, not all theories are able to account for psychopathology, and so particular attention will be given to evidence of psychopathology which may arise from microtubular quantum brain theory³¹.

The cause of many neurological diseases has been shown to be microtubule-associated protein-tau (MAP-tau) and microtubule damage. The job of a normal MAP-tau protein is to protect the structure and with it the functioning of MTs, to maintain the integrity of the inside of the cell and to form a relationship like a network with other cellular skeletons. The short function of MAP is to stick the parts of the cell together like a glue. In the brains of adult people, there are six types of MAP-tau protein, and in many devastating brain diseases it is damaged by combining with phosphorus. It loses its functioning as a result of this damage, and breaks down into a hard and indissoluble material inside the nerve cells. In this way, both with the loss of function and the breakdown, nerve cells lose their function and their integrity. Some of these degenerative brain diseases

have even begun to be examined under the name of tauopathies because of these disease-causing mechanisms. Among these MAP and MT-related degenerative diseases, which are neurological but often have a neuropsychiatric element, can be counted Alzheimer's disease, Niemann-Pick disease, fronto-temporal dementia, progressive supranuclear paralysis, Parkinson's disease, Lewy body dementia, Huntington's disease, Creutzfeld-Jacob disease, corticobasal ganglionic degeneration (CBGD) and Down's syndrome ³².

In Alzheimer's disease, in which intermittent fluctuations in consciousness and in particular short periods of memory loss and reduced attention are seen, abnormalities have been found in MAP-tau proteins. The genes coding the MAP-tau protein is on chromosome 17. These proteins are normally located on MTs and are attached to them. In this normal condition, there is a union of MAP-tau proteins and MTs. MAP-tau proteins preserve the structural integrity of MTs. Also, apoprotein E (ApoE) has the function of carrying serum cholesterol in the blood. The gene coding ApoEs is located on chromosome 19. It has different sub-units: apo-E2, E3 and E4. Apo-E2 and E-3 protect the MAP-tau proteins attached to MTs, and excess phosphorus, disrupting the functioning of MAP-tau, prevents bonding (*hyperphosphorylation*). Working in the other direction, ApoE-4 causes phosphorus to bind to phosphorus-adding enzymes and as a result of this addition separates MAP-tau proteins from MT ³³. The separated tau proteins bind with other tau proteins which are free in the environment or which have become separated, and form paired helices. There are different types with different names according to the dominance of their clinical characteristics. Their clinical appearance is different, and they can have positive (hallucination, thought disturbance) or negative (blunted affect, social withdrawal) symptoms.

Auditory hallucinations are often seen in schizophrenia (SCZ). These are generally religious and warning. Some are in the form of commands. Males generally hear them as commands, while females hear them as criticism ³⁴. External voices are sometimes heard by 30% of normal people, but these are not insistent. Visual hallucinations are also often observed. Thoughts occur which are contrary to logic and common sense ³⁵. Thoughts must accord with syntax, semantics, logic and emotional rules. SCZ patients in the early stages try to exert control over their thoughts and for this reason their thought processes slow as they try to impose conscious control over their subconscious thoughts.

SCZ was classically described as split personality. However, the splitting or break-up is not only of the person's own personality, but also of the relationship between this personality and the outside world or objects. People

with SCZ feel that they themselves and the reality of the world are different, confusing, uncertain or foreign. The characteristics of objects in the outside world cannot be defined or connected to each other. Because they have lost all of their internal locations, they also lose the defined meanings which they carried for cognitive life. SCZ patients have abnormal and different experiences of the outside world. Hallucinations arise from the different evaluation of internally formed experiences such as thoughts and external reality. Therefore, it is suggested that this disease involves a disorder of "self-monitoring". Once our mental states in daily life are formed, they do not remain there: the state of our mental self in the "now" is a continuation of a previous mental state, and our current self is the precursor to states of self which will form later. This continual stimulation awakens in us a feeling of wholeness and continuity, and at the same time gives us a sense of the flow of time. Mental events are in constant interaction with visual, auditory, tactile, deep sensory and olfactory stimuli coming from the outside world. In this way, internal mental states combine with bodily sensations and produce a localization of self in the body. When I have the intention to move my hand or arm, the combination of my internal mental state and the deep sensation that results at the time of my arm movement with my mental processes creates the feeling of the self in my body.

SCZ is evaluated by some people as "disorders of self or disorders of the boundaries of self". However, the self here and the "ego" of psychoanalysis are not the same thing. As described above, "self" relates to the internally and externally formed selves in the body. It is suggested that in sensory breakdowns or irregularities in time category, boundary breakdowns in irregularities in the category of object, and breakdowns in causality, SCZ psychoses must be mentioned. For example, SCZ patients often talk about problems with their "selves": "I feel that this thought is not my own, it's not me thinking my thoughts, there's a close relationship between these objects and me, my thoughts can affect objects and it's like that because I thought it, I myself am not real, there's a glass wall between me and everything else, time has disappeared..." etc.

Mental life exists primarily as awareness of present time. This awareness of now is not experienced as arising from mental processes which are not of the present moment but of the past. Awareness of the present continues without attachment to the past and without being affected, or only weakly, by what will happen later. This disintegration in internal time causes experiences described by many SCZ patients as an "extended or broadened present". Because of the disintegration of the connection between body and self, a SCZ patient's actions are experienced as produced only to a small

extent by the person himself and more often by others. Therefore, SCZ is not only the breakup of self and personality, but also the separation of self and the reality of the outside world. Integrated unity breaks down. It is for this reason that the term “lack of wholeness” has been proposed for SCZ. It is for this reason that some patients have a fixed idea that their thoughts are controlled by others. The feeling of being controlled by others weakens the self³⁶.

Perception is founded on three components: sensory input, the internal product of concepts and experience or censorship. There is a mutual interaction between these three and in SCZ the balance between them is upset. Rather than a breakdown of the censorship which protects the brain from the outside world, internal conceptualization appears with the breakdown of internal correction mechanisms interacting with sensory data coming from the outside world.

Quantum neuropathology in schizophrenia: microtubules

There is a high genetic disposition for SCZ and bipolar disorder: the concordance with monozygotic twins is 40%. However, the phenotype of the disease, that is its clinical appearance, varies. The change from genotype to phenotype with polygenetic factors (SNP, single nucleotide polymorphism) is not deterministic, and is quantum probabilistic³⁷. When searching for a relationship between the two, at least genetic relationships can be looked at as a common point relating both SCZ and MT. Many genes have been found to be related to SCZ. These can be grouped as the genetically related structures DISC-1 (disrupted-schizophrenia-1), NR-1 (neuroregulin 1-SNP), DYSB-1 (dysbindin-1) and STOP (Stable Tubule Only Peptide).

DISC-1 has important functions particularly in protein-protein interactions. It has an effect on the cellular skeleton by way of dynein. Dynein performs the function of transport over MTs, and functions in cell migration, the growth of cell extensions and the formation of axons. DISC-1 has functions at critical stages in brain development, in important nerve cell differentiation, proliferation and network formation in the mother's womb. It is found in large amounts in the brain in the dentate gyrus and the hippocampus. The DISC-1 gene is a risk factor for SCZ, BPB and recurring major depression. It normally allows neural development, plasticity, dynein movement along the MT, migration, proliferation and actin filament configuration³⁸. The structure of the MT matrix and the inside of the cells is directly connected by actin filaments to the nerve cell membrane. The actin filaments fill spiny dendritic projections and the positive ends of MT2s extend to these regions³⁹. The actin filaments, es-

pecially the dendritic spines, are very elastic and play an important role in learning and memory functions. MT tubulin expression is disrupted in SCZ by DISC-1 gene variations (beta-3 and delta-1)⁴⁰. In knockout rats, neural migration and dendritic branching are reduced⁴¹. Six abnormalities in the **Neuroregulin-1** gene have been reported in SCZ. They all have functions relating to the cellular skeleton. It enables cell proliferation, migration, neurite growth, synaptogenesis, maturation and myelination⁴².

The **Dysbindin-1** gene (*DYSB-1*) increases the risk of SCZ. It is related to MT, and is found in the terminations of axons, which are the extensions of nerve cells. It regulates the secretion of the neurotransmitter GLU. It is connected with NR-1. It functions in neural development and plasticity, and a deficiency disrupts cellular structure⁴³.

The **STOP (Stable Tubule Only Peptide)** gene has been found to appear predominantly in animals with intercellular synaptic dysfunctions and behavioral problems similar to SCZ. It ensures the structural integrity of *microtubule*-associated proteins (MAPs). It is one of the best models of SCZ, and regulates antipsychotic treatment and behavioral problems. When STOP is present, it binds to MT, and prevents the tubulins from breaking up. When this gene is removed, atypical behaviors occur and this is accepted as a successful animal model of SCZ. In rats without the STOP gene, deterioration occurs in recognition and long-term memory. This resembles memory deterioration in SCZ⁴⁴. At the same time, as glutamate levels fall as a neurotransmitter in their brains, there is an increase in dopamine⁴⁵. When MT stabilizing drugs and antipsychotics are given to rats without this gene, they show a better pattern of behavior⁴⁶.

In schizophrenia patients, disruptions in the concentrations in the brain of MT and MAP have been found. In SCZ, a reduction in MT in the anterior limbic system has been shown, and MAP-2 is reduced in SCZ in the prefrontal, subiculum and entorhinal cortex⁴⁷. Another developmental thought is that neurons have not been able to properly form the proliferation area of the cortex and the formation of further cortical layers. In the frontal cortex and the subcortical white matter, they detected an increase in the NADPH-diaphorase-positive nerve cell density. This study is in accordance with the observation of an increase MAP in the white matter of the front brain⁴⁸.

Antipsychotics, which are frequently used in SCZ, are effective over MT and MAP. It has been shown that antipsychotics increase the production of MAP⁴⁹, they protect the neuroskeletal structure from oxidative stress⁵⁰, they prevent MT swelling in cell cultures⁵¹, and that haloperidol and clozapine perform synaptic reorganization in MTs^{52 53}.

Quantum neuropathology in mood disorders

A reduction of serotonin in the brain causes a clear reduction in MAP-2. In rats, when levels of MAP-2 and alpha-tubulin levels fall in the hippocampal neurons, social isolation and recognition deficiencies occur⁵⁴. In SCZ also, defects in social interaction and the perception of social clues are an important characteristic of the disease. Plasticity decreases in animals in which shock-learned unhappiness or depression forms a similar picture. MAP-2 is reduced and this reduction is partly reversed by antidepressant treatment⁵⁵. In animals subjected to chronic unexpected stress (depression), acetyl tubulin increases (it makes stabilized MT) and tyrosine MT and phosphoryl MT decrease (that is, they become unstable and their tendency to break down increases). These skeletal changes are reduced by the antidepressant fluoxetine^{56 57}.

G-protein dynamics in G-proteins and cell membrane fat layers are in a close relationship with MT and intracellular skeletal structure⁵⁸. Fatty acids have a direct dynamic relationship to MT and the cellular skeleton⁵⁹. G-protein dynamics on the cell membrane are important in depression and suicide attempts⁶⁰. The same applies to thrombocytes in the blood⁶¹. With suicide, a rapid change takes place in GS-alpha protein. This is known as "the slide towards suicide". In depressive patients with a tendency to suicide, there is a higher level of GS-alpha protein in nerve cell membranes⁶². In connection with this, there is an increase in arachidonic acid in the brain and the reuptake of serotonin to the nerve cells is reduced with an increase in nerve cell membrane familiarization⁶³.

In Bipolar Disorder, valproic acid and lithium are generally used as a long-term treatment. Abnormalities have been detected in 34 genetic areas in bipolar disorder, and these genes are related to 18 tubulin proteins. In particular, a change occurs in beta isoform, and MT loses its structure and function⁶⁴. It has been shown that valproic acid inhibits tubulin polymerization in MTs and binds to MAP⁶⁵. It has been shown that lithium and VPA increase neurogenesis and increase beta-tubulin⁶⁶. It has been suggested that colchicine binding to tubulins in rats disrupts learning⁶⁷. It has been shown that hallucinogenic substances such as LSD and phenyl ethylamine damage the structure of the neural skeleton in humans⁶⁸.

In anxiety disorder, a protein called stathmin is found in the lateral nucleus of the amygdala and in the thalamocortical regions. The lateral nucleus has a function in fear and learning⁶⁹. When stathmin-producing genes are knocked out, rats are less aware of danger and their fears relating to the amygdala are reduced⁷⁰. They show less tendency to avoid dangers which they should avoid. Stathmin is found in very large concentrations in

nerve cells, and is an MT destabilizer, increasing its breakdown⁷¹. It is important for the reconstruction of the neural skeleton. Excessive production prevents the growth of dendrites. That is, balanced stathmin is a key factor in dendritic MT dynamics⁷².

Perception of reality and subject-object relationship

The understanding of the objective and real world occupies the minds of the members of three professions: quantum physicists, mathematicians and psychiatrists. The totally real understanding to the outside world almost disappeared a short time after the appearance of quantum physics, at least among some quantum physicists⁷³. To a quantum physicist, only what is measurable and observable is real. Until it is observed, reality stays in the realm of probability. We cannot fully know results, and all that we have is probability. For a mathematician, 'real' and 'correct' are equivalent in meaning⁷⁴. The way of working of mathematics is in fact simple. For example, let us take a real part of the world. This real world which we want to describe scientifically is the actual problem. First of all, a symbolic metaphor is developed. A mathematical model is constructed for the part of the real world which is being studied, and a part of the real world becomes an abstract copy in the mathematical world. The process of bringing about this mathematical model is this process of abstraction. Mathematics is at base divided into two: pure and applied mathematics. Pure mathematics is a game played in the mind. It mostly consists of symbols and equations set out on paper. At his stage, new ideational objects are created. Initial axioms move away from the reality of what is accepted. Pure mathematics is mathematics for its own sake and has no practical use in the world. The other branch of mathematics is applied mathematics, and is performed for "something else". That something else is always an aspect of reality and objectivity. Thus for mathematicians, there are two different worlds. One is the real world or the world of sensory experience. The second is the mathematical world or the world of ideas. This world is composed of imaginary mathematical objects like numbers, analytical functions, matrices, differential equations, series, and topological spaces. The mathematical world exists in the mathematician's head, while the real world is outside.

An object is a thing which can be perceived by at least one of the senses, has concrete existence in space-time, can be distinguished and recognized by the consciousness, and which is thought of by a thinking subject. In fact, the whole universe facing a subject is composed of objects. Because of the act of thinking, a subject can temporarily become an object in any condition which

the subject imagines for itself. Being objective and being real are different from one another. There are different forms of objects. 1. *An ideal object*: one found in the consciousness as a result of pure thought, and having no existence without thought. 2. *A real object*: an object existing in the outside world independent of a subject, thought or consciousness, and which would exist even if we did not. 3. *An abstract object*: these are numbers and geometrical figures, which do not occupy space-time. Maurice Merleau-Ponty states that a distinction must be made between subject and object, and says that “everything which there is exists either as a thing or as consciousness, and a third state other than these or even a mid-point is out of the question”⁷⁵.

For a psychiatrist who meets a schizophrenic patient, the understanding of the objective world is confusing. Objectivity in general psychiatry is paramount, but the interest of the psychiatrist is the mental and internal life of the other person. Karl Jaspers, in his *General Psychopathology*, defined delusions as “beliefs which can neither be proven or disproven”, and this statement is the cornerstone of the diagnosis of psychosis⁷⁶. A diagnosis is a reflection of classical Newtonian physics, is founded on an acceptance of a “single objective external reality”. This single and objective reality is the source of all internal experiences. In 1913, the year in which Jaspers’ book was published, the quantum physicist Niels Bohr published the quantum theory of the hydrogen atom, and made the confusing proposal that there might not be a single objective accepted reality, but that it came into being by observation. This was later accepted by many quantum physicists as a result of experimental research. For example, in a double slit experiment, if you observe subatomic particles behaving as particles, when you do not observe them, the same particles show wave behavior. In this situation, a reality forms which changes according to the observer, implying that there is no single objective reality. This being so, how can a diagnosis of psychosis be made based on the concept of a single reality⁷⁷.

Many-worlds, multiverse and multimind

The idea of parallel universes has recently taken an important place in popular culture, and has figured in films and many books. Parallel universes are not just science fiction but may be a characteristic of the universe. The idea of parallel or multiple universes may seem like a fantasy, but when participants at an international physics meeting in 1997 were asked which view they favored as a solution to the measurement problem, the Copenhagen interpretation came first and the Many-Worlds Interpretation (MWI) second⁷⁸. Stephen Hawking (1942-2018), Murray Gell-Mann and Richard Feynman (1918-1988) all responded to the MWI by saying they thought it was real. Only Roger Penrose did not accept it. More

than three hundred published articles are to be found on the topic in the relevant physics archives. Just as there may be other dimensions in the universe in which we are located, there may also be other universes beyond the horizon of our universe. However, the subject is still at a theoretical level, and is far from being tested experimentally.

The MWI was proposed in Hugh Everett’s doctoral thesis⁷⁹, and is one of the solutions to the problem of the measurement problem in quantum mechanics. It has also been called the many minds interpretation. In this theory, each of all possible states can be found in reality in different universes. According to Everett, everything possible is to be found in a huge universe as small probability universes. There are people observing each one of the states of probability in many sub-universes. However, these people or their minds are not aware of each other. Thus for example, if you have a choice in front of you of tea, coffee or fruit juice to drink and you choose the coffee, copies of you will separate into as many different universes as there are choices. That is, there will be a copy of you in one universe that chooses tea, and one in another universe that chooses fruit juice. They continue with their lives, and it is because you chose coffee that all the events take place in this objective world⁸⁰.

Considering the quantum measurement problem, for the condition of every cat in our universe for which the possibility has not collapsed, there is a cat in another universe for all possible results. A universe forms for the observer who sees the dead cat and the dead cat itself, and another for the person who sees the cat as alive and for the living cat. These two universes are inside a larger universe. Given that the state of consciousness and the mind of each observer “splits into two”, each observer will exist twice, and will have different experiences in each existence. The whole universe in which the observer lives splits into two or more multiple or parallel universes at each “measurement”. As a result, the “branches” of the universe spread out unbelievably. In fact, the choice of each possibility will exist at one point. Can relations or communications be established between divided multiple parallel worlds? According to MWI, each division is thermodynamically irreversible. Events in our minds are also irreversible. Normally, this division would not be noticeable to us. In order to choose and be aware, we need to have a reversible mind. According to general belief, we can detect other worlds with a reversible mind. If worlds are dividing, where are the other worlds? Why are we not aware of them? Why do we only ever experience a single world? The answer to these questions is not very clear. In his book *Other Worlds* (1997), the physicist Paul Davies wrote this about Everett’s multiple universes:

...we don't even know if they are suitable for life. In Everett's theory, all these other worlds really exist alongside us. According to a more traditional theory, these are potential worlds which have most likely not come into existence, but nevertheless may exist in the far future or in another part of the universe. Maybe our tiny, extremely regular world is just a small hospitable bubble in this mainly chaotic cosmos, and the reason why it is seen only by us is that our existence is connected to the mild conditions here.

Fred Alan Wolf discusses the possible existence of people in parallel universes:

*In a parallel universe there are not only other people, at the same time these people may be copies of us, and are only connected to us through mechanisms which can be understood by using the principles of quantum physics*⁸¹.

Also, in an interesting view, he draws attention to the possible relationship between the closeness of parallel universes and conditions of psychiatric disease:

If the parallel universes of relativity are the same as those in quantum theory, it is possible that parallel universes may be very close to us: this proximity may be only at atomic scales, or it may be at an astronomical scale. Modern neurosciences show, with research which has been conducted on states of altered awareness, schizophrenia and dreaming, that parallel worlds may be close to us.

Hallucinations and thought insertion

The most noticeable characteristics of schizophrenia patients are auditory or visual hallucinations, obsessions which cannot be proven or disproven (delusions), and impairment of thought content (thought intrusion, insertion, monitoring, broadcasting). Bleuler in 1911 used the term schizophrenia, meaning "splitting of the mind", but in fact there is nothing like that. In schizophrenia patients, there is an inability to distinguish the real from the unreal⁸². In thought intrusion, a thought occurs, but is not perceived as being the person's own thought. Rather, it is perceived as being someone else's thought, but at the same time it is a very clear thought^{83 84}.

Hallucination is defined in DSM-III-R (p. 398) as "a sensory perception occurring without external stimulation of the relevant sensory organ." Being in a hallucinatory state has been defined as "... a person who believes he/she has perceived something when there is nothing in the sensory field which could cause such a sensation"⁸⁵. About 30% of the normal healthy population has experienced a hallucination at least one time. Approximately 16-70% of schizophrenia patients have visual

hallucinations. In people who experience hallucinations, their clinical situation is slow and poor. Visual hallucinations can be very variable, but many have much in common, and can be in the form of spirits, dead people, prophets, devils, God, sages, or sometimes space aliens. The type of hallucination is generally closely related to the social and cultural environment in which the person grew up. In places where religious factors or tendencies are strong, visual hallucinations have a religious basis. More than seeing things which are not there, schizophrenia patients have a greater tendency to hear imagined sounds: nearly 63% of patients hear such sounds. These sounds come in the form of voices speaking, voices speaking their own thoughts, and voices giving warnings or making threats. A person is talking about himself and listening. In fact, he doesn't know the source, but ascribes it to the TV or another source. It can be in the form of orders or comments. It may be wrong to call these "voices". Some, as with the visual hallucinations, hear the voice of spirits or of God, and others state that they can hear the voices of dead people, prophets, or devils. Various mechanisms have been proposed for the occurrence of hallucinations. These include defects of neural sensory mechanisms, revival of previous memory remnants, and perceptual liberation.

Along with hallucinations, schizophrenia patients also have delusions⁸⁶. These come in many forms, and can include feelings that their minds are being read, that harm is about to be done to them or that they are being poisoned, that their thoughts are being broadcast and are known to everyone, or that others can affect their thoughts from a distance. There is also a delusional feeling of being in love, which is seen in 6% of these patients. There are also mystical delusions, such as of dying and coming back to life, or that the world has ended and will be destroyed.

In thought insertion/intrusion, there is an outside agency which is like a guest in the person's mind. The thoughts of this agent are added to the patient's own, and it is different from thoughts being controlled from outside. In this situation, two people are thinking in the person's self and brain. One of these is the familiar self, while the other is a stranger or a thought other than the person himself. The person is consciously aware of his own thoughts and at the same time someone else's thoughts. Even though there is unity of consciousness, the agency is separate. It is not the person himself, it is like another/multiple or parallel thought. Where is the source of this second personality? The subconscious? Is it a separate delayed function of the brain? Is it the work of the left hemisphere of the brain, distinguishing what is itself and not itself? Is it thoughts coming from another universe? Is it the confusing effect of other personalities in other

universes? Some of these are fictional, and some beyond fiction. Nevertheless, these are questions which must be considered.

Seen from the point of view of quantum brain theory, all of a person's mental structure relating to thermo-field brain dynamics arise from the relationship between sensory input, memory traces and self-tuning. The origins of thermofield brain dynamics go back to the quantum brain dynamics of Umezawa and coworkers⁸⁷. Vitiello greatly extended quantum brain dynamics to a thermofield brain dynamics by bringing in dissipation⁸⁸. It was recognized that symmetry-breaking in the ground state of the brain-the vacuum state of a water electric dipole field-offers a mechanism for memory. Sensory inputs fall into the ground after dissipating their energy and break the dipole symmetry. The broken symmetry is preserved by boson condensation (Nambu-Goldstone condensates). When the sensory input is repeated, the condensate-trace is excited from the vacuum state and becomes conscious. Thought intrusion arises from disorders in the inadequacy of response and the flow of information. Seen from the point of view of covered or hidden order, which is another quantum brain theory, behind the real universe which we see and the objective world, there is a hidden structure which shapes it, and a hidden structure in the form of a quantum field is connected to the brain. Affecting the brain, it provides thoughts, beliefs, feelings, perceptions, emotions and desires. Hallucinations may be interference caused by a hidden order in the brain⁸⁹.

Health is the whole of the state of mental and bodily wellbeing. According to David Bohm (1917-1992), mental health is basically related to the whole hidden below, and to flowing consciousness. Disruption of the whole occurs with mental disorder. Quantal information in Bohm's *implicate order* determines effect and particle behavior⁹⁰. For example, when we see a snake, a perception of danger occurs and fear develops. How does the mental side affect the brain in this situation? Quantum field information causes the particles to dance and affects the chemistry and physics of the physical brain. Bohm called this pass effect "soma significance", and the effect on brain physics "signa-somatic". In this situation, the human mind and consciousness are sometimes subtle. That is, it is a non-physical structure. It is probable that information experienced in consciousness is like a volatile invisible quantum field. Objectivity, mind content (qualia), and the experience of consciousness take place here. This typically affects downwards and accompanies behaviors. However, it is more important how this subtle field affects the brain, and this is probably done with a quantum field. A quantum field carries active information, and continuously provides a condition of

creation (consciousness, thought...) by having an effect on particles. This is one of the best explanations of the mind-brain model since Descartes⁹¹.

In Bohm's quantum field theory, the non-material consciousness may enter into relations with the material brain through the effect on tubulin dimers in the MTs⁹². Changes in the quantum field in the environment of the related MTs changes the behavior and position of electrons. As a result, large-scale neural behavior appears with MT tubulin changes which occur successively in a domino effect (alpha-beta). This leads to kinetic or emotional results. The effect of quantum force on nerve cells is the spread of desire or intention. There is a mutual two-way effect, and this is an effect which is also not dead material. This interaction is completely under the control of "active information". The quantum field carries information on the environment of the particle and as John Wheeler said, "reality is information". The field turns into a quantum potential, and affects particles, determining their behavior. This is not a mechanical effect. Its appearance in mental illnesses happens with the effect of information of discordant and disturbing thoughts. These are perceptions which are unwanted but which we become aware of (*mind-popping or mind wandering*). Bohmian theory may also be connected with Eccles' psychons (the smallest cognitive units) and dendrons (the smallest units of the physical brain). Dendrons are places of intense synaptic joining, and at the same time are suitable places for Walker's electron quantum tunneling. Also, these regions are areas of dense MT.

The question arises as to whether hallucinations, delusions, thought intrusions and indecisiveness (ambivalent thoughts) in schizophrenia patients may be a result of setting up interference connections in minds in this universe with these parallel universes, collective consciousness/mind in the hidden order, or with our other minds making decisions. According to the physicist David Bohm (1917-1992), the universe consists of two basic structures. Behind the objective, what we call real, universe, is another potential, hidden world which gives it form and which contains all the entities of this universe. This deeper level of reality is called "implicate order", and the level or existence in which we are located is called "explicate order". Seen in another way, electrons and all other particles are no more than the temporary form taken by water bubbling from a spring. These are supported by a constant flow coming from the implicate order, and when we see what looks like a particle disappearing, it does not in fact disappear. In this situation, the particle has merely returned from its structure to the order in the depths from which it emerged⁹³.

The quantum information in Bohm's implicate order has the effect of determining particle behavior. For example,

when we see a snake a feeling of danger arises and fear develops. How does the cognitive side affect the brain in this situation? The quantum field information causes the particles to dance and affects the brain's chemistry and physics. Bohm called this crossover effect *the emergent effect in the body*. In this situation, the human mind and its information are carried by a subtle structure, that is, a non-material structure. It is probable that knowledge experienced in the consciousness, visible or subtle, is like an invisible quantum field. Objectivity, that is individual mind content and conscious experience, is located here. This typically affects downwards and accompanies behaviors. However, the way this *zahir* field affects the brain is more important, and it probably does this by means of a quantum field. A quantum field, like a'yân thâbita, carries active information, and produces a state of continuous creation with its effect on particles. This continuous creation in the outer world brings subatomic particles into existence in the objective world, while the same process in the brain causes mental images and momentary thoughts. How do our perceptions and thoughts affect our physical brains? This, according to Bohm's approach, happens by a route called the "reverse effect". That is, the effect happens from the field to the particles. The material brain, that is the physical brain composed of particles, affects the accompanying super-quantum field (a kind which is covered or implicate). In the opposite way, thoughts resulting in movement or speech (kinetic output) appear with the effect on particles of super quanta.

Bohm's theory is in some ways similar to the thoughts of Ibn Arabi⁹⁴. The relation of the *bâtin* (inward, hidden, internal) to the *zahir* (outward, visible, external) and the formation of what is *kesif* (coarse) from what is *latif* (refined, subtle) of Ibn Arabi's view of the universe are the same, with small differences. Ibn Arabi gives the name a'yân thâbita (fixed entities, archetypes) to the implicate order, and this is the field of imagination in the divine consciousness if God. The a'yân thâbita are the "fixed prototypes" or "latent realities of things". The fixed entities are not the "archetypes" of the existent entities but are rather identical ('ayn) with them; nor are they "essences", if by this is meant anything other than the entities' specific whatness. The original copies there take on a dull existence, including space and time, in this universe of Einstein's. a'yân thâbita is a field which has no actual existence, just like a universal quantum probability wave. It contains potentially within it all the possibilities of existence. It has not yet come to reality and has not manifested itself.

Even if this model is accepted as one of the best consciousness-brain explanation models put forward since Rene Descartes (1596-1650), it is true that Ibn Arabi (1165-1240) had done this some 700 years before. The

quantum universal field potential is like a kind of implicate and explicate order, a Noosphere, Gaia, universal subconscious, biologist Rupert Sheldrake's morphic fields, neuroscientist John Carew Eccles' (1903-1997) quantum psychons, psychiatrist Carl Gustav Jung's (1871-1961) archetype, mystic Ibn Arabi's a'yân thâbita and *levh-i mahfuz*, philosopher Karl Popper's (1902-1994) cognitive worlds, or Plato's world of ideas. All these names are labels proposed by different people for the place where the original structure is stored which provides a common consciousness-mind or a coming into existence.

In Bohm's quantum field theory, the non-material consciousness may enter into a relationship with the material living brain by influence on the tubulins which form the skeleton in the nerve cells. Changes in the quantum field around this cellular skeleton change the behavior and position of electrons in the material structure. As a result, tubulin changes (alpha-beta conversions) in the cellular structure following each other in a domino effect produce observed behavior spreading to the large-scale nerve cell net. This leads to movement or speaking, or has sensory results. The effect of quantum force on nerve cells is the spread of desire or intention. Here, there is a reciprocal, which is two-way, interaction between the mind and the brain. The reciprocal interaction is an effect which is not in dead material. This interaction is completely under the control of "active information". The quantum field carries information about the environment of the particle and as the physicist John Wheeler said is "reality information". In other words, the quantum field changes to a quantum potential, it has an effect on particles at the cellular level, and particle effects in total act on the material structure in the nerve cell and determine its ultimate behavior. The same mechanism may be thought of for the quantum field effect on Eccles' dendrons and Umezawa's corticons. This is not a mechanical effect. With all this information we may reach this conclusion: the appearance of mental illnesses occurs with a reflection on the brain of the information of incongruous and disruptive thoughts. These are perceptions which we become involuntarily aware of, like mental hiccups, mental wandering or random thoughts.

Sudden thoughts coming out of nowhere

These are words, images or music that suddenly pop into our consciousness seemingly out of nowhere. They take the form of sudden information or music, and have been called mental hiccups or mind-pops. Very often, these uninvited thoughts have nothing to do with what our minds are currently occupied with. According to some scientists, these sudden thoughts are not entirely random but are connected to our knowledge and experience of the world. Some people often have mental hic-

cupps, and these contribute to their creativity. They make problem solving easier. They generally appear 90% of the time when the person is alone and when performing routine work, and they appear without mental effort. These mental wanderings appear of their own accord and unbidden, and so cannot be controlled. They can come to mind while we are brushing our teeth or tying our shoelaces. That is, they appear when the mind is free and when we are not concentrating on anything. The most important sign of a mental hiccup is that the thought has no relation to what is going on in the mind at that moment. In some circumstances, the triggers for the mental hiccupps can be identified, and these are subliminal. Sometimes connections may be formed with events which happened a few hours or a day previously. That is, the thoughts did not come entirely of their own accord or by chance, but were connected to previous mental states. In terms of their content, these verbal, visual and musical mind-pops are different from several other involuntary phenomena described in the literature⁹⁵.

These mental hiccupps may be the source of thought intrusions and hallucinations. In persons with diseases like schizophrenia, harmless mental hiccupps may turn into hallucinations. When schizophrenia patients and normal individuals were examined with regard to these mental hiccupps, interesting findings appeared. In particular, it was found that they appeared in great variety to the schizophrenia patients, and with a frequency of about 3-4 times a week, whereas they happened 3-4 times a year in the normal people and 1-2 times a month to the depressive patients⁹⁶. It can be seen from this that in the case of a mental illness such as schizophrenia, mental hiccupps are very frequent. However, it is not scientifically possible to make a connection between these sudden thoughts of unknown origin and hallucinations.

Wandering thoughts

This condition, like mental hiccupps, means thoughts which are unrelated to what the person is doing at that moment. It may be called mind wandering, daydreaming, or being lost in thought, and it generally happens while doing something which does not require attention, such as while reading or driving^{97 98}. The person is occupied with his thoughts, and it makes little difference what is going on around him. Daydreaming may even be a gift of evolution: it may stimulate creativity and keep the mind active. A person may be aware of mental wandering, or partially unaware. In general, people are unaware one third of the time. Thus, when a per-

son studies for an hour, his mind may be elsewhere for twenty minutes. For example, when a person is reading a book, he may be unaware that he has left off reading and that his thoughts have gone elsewhere until someone alerts him. "What are you doing? Oh, er, my thoughts had drifted off..."⁹⁹.

Conclusions

Many quantum psychopathology hypotheses may not be testable. Quantum mechanical analogies may provide a better understanding of patients. The use of quantum insight – used heuristically by experienced psychiatrists – provides better clinical results¹⁰⁰. Although there have been different *Diagnostic and Statistical Manual of Mental Disorders* (DSMs) at different times, there has been a general trend towards pathology. DSM-I (1952), DSM-II (1968, 1974), DSM-III (1980, revision-1987), DSM-IV (1994, revision-2000) and DSM-V (May 2013) are basically not very different from each other. If we add the accumulation of symptoms of 1980, the multi-axis system of 2000 and the dimensional variables of 2013 to the DSMs, there are many psychiatrists who are not satisfied. DSM-V has been criticized as being a possible cause of medicalization, with the excessive and unnecessary use of drugs. For example, normal grief may now be taken as pathological. A diagnosis is traditionally given with scientific clinical findings, and these diagnostic measurements may take shape under the influence of *American Psychological Association* subcommittee dynamics, pharmaceutical companies, the press and media organs, and patients' rights groups. There is no effect of quantum physics in DSM-V, and it is affected by classical physics. Knowledge advances in its normal phase¹⁰¹. DSM has not yet made that leap, and can be seen to be advancing in slow steps. To repeat Karl Jaspers' words: *Having excluded all theories regarding the mind, we must find a way to develop theories to be used in describing the minds of other people, (1963). The purpose of psychopathology is to create clear theoretical awareness of what is known, of how it is known, and of what is not known (1957, p. 19).*

Conflict of interest

The Author declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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