



Theoretical Models of Schizophrenia

Ida Liliawati

Universitas Pendidikan Indonesia

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Abstract

The models that have been suggested to explain schizophrenia range from more general drawings of how some signs may be generated to more comprehensive description that attempt to account for the diverse exhibitions of this impairment by portraying interruptions of complicated interplay between different pieces such as neural pathways, neurotransmitters in the brain, and parallel distributed processes. These models were developed in an effort to provide an explanation for the plethora of symptoms that are associated with schizophrenia.

Background

If it weren't for the theoretical models, the findings from neurophysiology, neuropsychology, and psychophysiology that point to biological coexists with schizophrenia would give a pointless matching between mental entity (disorder or personal symptom) and brain part even if they were simple and consistent. These frameworks are formed to describe the distinct functional role and responsibilities of systems consisting of structural elements that communicate to generate a mechanism by which mental processes, and their misbehaving, occur. The purpose of constructing such models is to shed light on the mechanisms by which psychological events happen. If we didn't have these predictive concepts, it would be like trying to describe where various pieces of a vehicle are placed and what their separate roles could be without also explaining how these parts interact with one another. It is not clear how well the radiator cools the motor, how the motor moves the wheels, and how the battery offers a spark to activate burning in the motor pistons from the description that the radiator, that what supplies resource that specifies, is close to the motor, which provides rotary motion, and which is close to the battery, which supplies electric power. The radiator stores coolant, and the motor produces rotational energy. Furthermore, the localization of function does not provide light on how the separate pieces are responsible for producing the functions.

Meehl: Schizotaxia Model

Meehl's (1962, 1990) fundamental hypothesis states that a solitary schizotaxia gene is responsible for the susceptibility to develop schizophrenia, and that the full representation of schizophrenia is dependent on a large number of other genes as well as the social environment, which contains its own inherent consequences and rewards [1]. The gene leads to the development of a schizotypal personality, which can only progress into schizophrenia if other genes, such as those for social anxiety, anxiousness, low energy, apathy, or others, are also present in the body of the individual within the context of a social environment that is typical but demanding. Meehl refers to the hypersensitive nerve conduction that results from the single schizotaxia gene as "hypokrisia." This condition may be caused by stimulation that takes place anywhere in the central nervous system. The hypokrisia causes a condition known as "cognitive slippage," in which information does not get processed in its usual sequential manner but rather becomes jumbled. Even while the phenomena affect every part of the brain, it is only some cognitive functions—specifically, those that involve the integration of information—that are clearly impaired. The general intelligence may

continue to function almost normally, however cognitive slippage is characterized by a loosening of linkages with arbitrary linkages of ideas. This loosening of associations is a significant aspect of thinking disorder. As a result of this cognitive deficit's interference with social competence, there is a "aversive drift," in which unfavorable experiences in social situations lead to retreat and the manifestation of negative symptoms. Cognitive slippage may also result in strange feelings, which can then lead to hallucinations, the latter of which are thought to be explanations for the experiences. These interpretations are not seen as being particularly different from the cognitive biases, mistakes, and distortions that are routinely observed in the general public. For instance, people's faith in horoscopes and their anticipation of the lottery winning are both examples of this phenomenon. However, certain delusions might be more straightforwardly linked to cognitive deterioration if they actually make connections between events that are not related to one another. For instance, a schizophrenia sufferer may interpret the coughing of a stranger on a bus as a sign that they should leave their home if the coughing occurs at the same time that the person is considering leaving their home.

The cognitive coordination model developed by Phillips and Silverstein:

In addition to the fact that certain activities of the brain are assigned to certain areas of the brain, these functions are also helped in their integration by extended connections both within and between the regions of the brain. When these connections are disrupted, there is a disturbance in cognitive synchronization, which leads to the symptoms of disorganization. These symptoms are similar to those that are found in schizophrenia patients who have thinking disorders. The use of relevant details to disambiguate information and, as a result, constrain possible future perspectives on the meaning of a trigger to those that are relevant to the current sense, based on its previous occurrences, requires cognitive coordination. Other functions that require cognitive coordination include the grouping of items into units, the management of selective attention, i.e., the maintenance of detachment between units, and the utilization of contextual information. A disorderly train of thought is often the result of improper functioning of various cognitive processes. It is believed that a reduction in the flow of ions via NMDA receptors is to blame for the disruption in the linking fibers that are crucial for cognitive coordination across and within cortical brain areas. This hypothesis does not discount the many findings that point to the possibility of a role for dopaminergic systems in schizophrenia; rather, it focuses on the possibility that glutaminergic systems across the brain are involved. According to the authors of the study, glutaminergic receptors may be found throughout the cortex; however, they are found in particularly high concentrations in the frontal cortex, the hippocampal, and the striatum.

Parallel Distributed Processing

According to Hoffman In order to validate models of the brains in terms of the cognitive processes it underlies, computational methods have been used. Neuronal networks interacting with one another in a multidirectional manner across parts of the brain are the focus of one overarching concept of how the brain performs its functions. This technique has been used to support the concept that the neurological malfunction linked to the symptoms of schizophrenia includes impaired communication across cortical areas as a consequence of abnormal pruning of axonal parallel fibers throughout adolescence, especially in the prefrontal cortex. This cutting of axonal collateral fibers takes place in the prefrontal cortex. The computer simulation that was connected with the pruning of linkages between cortical areas resulted in the production of "parasitic foci," which are regions in the cortex where data is produced continuously in a way that is insensitive to information from other cortical areas. The behavior of these foci generates the perception that ideas, images, and concepts are being produced unwillingly in a manner that is comparable to the manner

in which involuntary motions during epilepsy are produced by unchecked neural action in cortical motor areas. This activity produces the feeling that ideas, images, and ideas are now being created involuntarily. As a consequence of the activation of these parasite foci, individuals may experience hallucinations, delusions of control, and delusions in general. Avolition is one of the negative symptoms that might occur if the repeated activity of the parasite foci creates meaningless output. Other negative symptoms include thought blockage and thinking withdrawal [2]–[6] [7]–[11].

Kapur: Salience Model

A concept was presented by Kapur (2003) in which an excessive amount of dopaminergic release leads to an exaggeration of its supposed central function... to modulate the 'salience' of external events and interior representations [12], [13]. This implies that the person with schizophrenia attaches a greater substantial significance to sensations in the outside environment as well as ideas from inside themselves than is generally justified by those stimuli or those thoughts. Since there are increasingly many things of attention in the memory to successfully manage, this pervasive weighing of meaning may lead to confusion. After then, the person will construct explanations for this odd subjective experience in the form of delusions in order to explain for it. It's possible that the "immediate perception of the abnormal prominence of internal representations" is what causes people to have hallucinations. [14]–[18]

The stress response model developed by Walker and Diforio

An overactive dopamine (and potentially glutamate) system; an overactive HPA reaction to stress, which results in excess glucocorticoids that aggravate the overactivity of the ventral striatum; and a pre- or perinatally damaged hippocampus, which results in a lack of inhibitory response to the production of glucocorticoids are the three components that contribute to a person's susceptibility to developing schizophrenia, according to the model developed by Walker and Diforio. Because of the way these systems interact with one another, the disruption of any one of them might result in a deterioration of the other two [19], [20]. Exacerbations of these aberrant hormonal and neuronal responses may be brought on by everyday stresses with no additional precipitating factors required. Positive feelings might be the consequence of an increase in dopamine activity, whilst negative symptoms could represent adaptive reactions designed to lower stress levels. The regular rise in cortisol production that occurs throughout adolescence may be one factor that contributes to the full presentation of symptoms beginning around this time [21]–[25].

Weinberger: Neurodevelopmental Model

Weinberger (1987) proposes that schizophrenia is the result of a pre- or perinatal brain lesion (produced by genetics and/or the environment) that does not become apparent until normal neurological growth and common stressors (especially those that occur during emerging adulthood) result in its outward manifestations [26], [27]. The prefrontal lobe is where the lesion is located in the brain. The ventrolateral prefrontal cortex matures in early adulthood during normal development. This is accompanied by an increase in dopaminergic activity, which regulates the simultaneous rise in dopaminergic activity in the limbic system, including the medial temporal region. This maturational level combines with the latent lesion to cause a deficiency in the amount of dopaminergic stimulation of the cerebral lobe produced by structures in the midbrain in people who have schizophrenia. The insufficient amount of activity in the frontal cortex prevents it from

being able to control the excessive amount of dopamine activity in the lateral temporal lobe. Environmental stresses are a factor in the disproportionately high amount of limbic activity and the inadequate amount of frontal activity. The former causes the manifestation of good symptoms, whereas the latter causes the manifestation of negative symptoms [28]–[32].

Nucleus Accumbens Concept

A complicated model that is based on a region located in the basal forebrain called the nucleus accumbens has been described by Grace and her colleagues [33]. This little region of the brain is found at a confluence of projections coming from the hippocampal, the frontal lobe, the brain, and the ventral striatum dopaminergic tract, all of which are regions that have been linked to possibly being altered in schizophrenia. According to this concept, the glutaminergic input from the prefrontal cortex to the nucleus accumbens regulates the cholinergic input in such a way as to affect the activity of dorsal circuits. In addition, the nucleus accumbens' gates are controlled by the hippocampus and the amygdala, which makes it possible for the frontal-subcortical circuitry to become active. A lack of glutaminergic regulation of the dopaminergic impact over the lateral circuits is associated with schizophrenia. This malfunction of the frontal lobes is caused by schizophrenia. A reduction in the level of tonic cholinergic activity causes a corresponding reduction in circuit activation. In addition to this, when there is less hippocampus input to the accumbens, there are fewer open gates, which means there is less transfer of the circuit flow from the frontal to the subcortical regions. This hypoactivation leads to diminished action, thinking, and feeling, which are represented as the unfavorable symptoms of avolition, apathy, and flattened affect respectively.

The positive symptoms, in particular reality distortion, are caused by an abnormal firing pattern in the hippocampi. This leads to either very few gates getting opened in the forebrain with a shift toward a greater preponderance of related brain gates in the forebrain being open (and consequently more awareness to fear-related items, as in paranoia), or to ungentlemanly gates being opened, which results in incorrect sensory stimuli being integrated into the go to attend situation.

BN has been linked to impairments in inhibitory control mechanisms. The nucleus accumbens (NAc) and caudate nucleus (CN) of the basal ganglia are components of the frontostriatal circuits implicated in inhibitory regulation [34]–[37].

Grace and colleagues think that thought disorder is caused by reduced activity in the accumbens (lower levels of tonic dopaminergic) resulting in lower inhibition in the substantia nigra, which typically inhibits the reticular ventricular nuclei. Because of this, there is an increase in inhibition of the parenchymal thalamic nuclei, which reduces the function that these nuclei play in filtering sensory information to the thalamus. This, in turn, causes difficulty in keeping attention and organizing one's thoughts [38]–[42].

Willed Intention Model, Developed by Frith

Frith notes that actions may take place either as a reaction to external signals (stimulus intents) or as a consequence of internal choices based on the individual's objectives and plans [43]–[46]. When actions are taken, a centralized monitoring system will differentiate between the two on its own. In schizophrenic, there is a breakdown in this central management mechanism, and as a result, acts that are the result of willed intentions are misinterpreted as being the result of influences from the outside world. This misunderstanding gives rise to delusions of control, which is the conviction that one's actions are the result of the actions of others; by assuming ideas to be a kind of action, mind insertion is the conviction that one's thoughts are the result of the thoughts of others. When a

person believes that their ideas are being generated by something outside of themselves, this might lead to hallucinations. Delusions of relevance or paranoid delusions are both caused by an inability to appropriately appraise the intentions of others. Negative symptoms are caused by a separate process, which is a lack in forming willed intents. This makes behaviors far more reliant on sensory input. For instance, a person who suffers from avolition may need the encouragement of another person in order to get up from bed and go for a stroll.

Frontal structures, the ventrolateral prefrontal cortex, the additional motor area, and the cingulate cortex are the brain correlates of this paradigm. Frontal structures trigger basal ganglia (ventral striatum) structures, which ultimately create movements. Because the frontal components also transmit corollary impulses to the areas of the posterior brain that are involved for perception, it seems as if the action was self-generated. These disconnections lead to the mistaken notion that willed intents are formed by sources outside of the individual; as a result, delusions and hallucinations take place. Negative symptoms tend to emerge if there is a disruption in the connections between the frontal and striatal regions [47]–[50].

Cohen: Cognitive Control Theory

According to the research of Cohen and coworkers, information processing may be impeded when there is insufficient cognitive control of the processes that are involved [51], [52]. The capacity to appropriately retain and update mental images of task-relevant context information," is what they define as "cognitive control" in their model. Inadequate cognitive control may lead to disorganization in both thinking and behavior, as well as deficiencies in the performance of cognitive tasks.

The prefrontal cortex is primarily responsible for the function of cognitive regulation. The inability to "internally represent and utilise context information in the interest of asserting control over behavior" is the underlying cause of problems with attention, executive functions, working memory, and episodic memory. This weakness may be traced back to a single underlying cause. When it comes to the process of maintaining and updating context, the prefrontal cortex plays a vital role. Dopamine input to the frontal cortex regulates the activity of the frontal cortex by filtering contextual information. This allows for the information to be updated while preventing interference from information that is not relevant. Dopaminergic pathways in the brain are responsible for "[giving] the mechanisms for the animal to learn about, anticipate, and react correctly to events that result in to reward," as stated in a generic sense. The many receivers of dopaminergic input—the limbic system, the striatum, and the cortex—each make unique contributions to the completion of this overarching goal. Dopaminergic input to the frontal cortex, in particular, allows for the updating of relevant information as well as protection against interference. Throughout schizophrenia, there are disruptions in the interaction of the dopamine forecasts to the prefrontal cortex. This can lead to perseveration, which occurs when there is an absence of up-to-date information to guide behavior; the incorporation of irrelevant information, which can disrupt the use of crucial data; or an impairment in the ability to maintain information. These disturbances lead to deficiencies in cognitive function as well as disarray [53]–[55].

The Motor Program Model Proposed by Gray and Hemsley

A complicated neurophysiological model is proposed by Gray, Feldon, Rawlins, and Hemsley in 1991 in order to provide an explanation for Hemsley's psychological premise [56], [57]. According to Hemsley's postulations, a "final common route" might be a "failure to integrate contextually relevant stored data with present sensory information and ongoing motor programs." Gray develops a model based on this idea to describe the positive characteristics of schizophrenia as a breakdown

in the smooth execution of planned "motor" routines. The model was developed using this approach.

Dopaminergic input to the frontal cortex is required for motor programs to have the following components: (1) the continuation of a given step until it is finished (corticothalamostriatal loops); (2) the evaluation of whether the final output of a step resembles the expected goal (septohippocampal system); (3) the termination of a step (monoaminergic input towards the nucleus accumbens); and (4) the progression to the next step in the initiative (nucleus accumbens). Additionally, the particular substance of each step has to be decided (caudate) depending on the reinforcing contingencies that may arise (amygdala). It is necessary to suppress irrelevant connections (in the striatum), while simultaneously keeping an eye out for significant unexpected incursions (septohippocampal system). In conclusion, the successful functioning of this system requires the coordination of these many tasks (prefrontal cortex).

Due to an impairment in the connection first from hippocampus via the scopus to the frontal cortex and/or due to overabundance dopamine main cause revocation of the intended motor program, it is open for invasion by novel or irrelevant stimuli, schizophrenia causes irrelevant stimuli to enter into the procedures of a motor program, causing it to be disrupted. When a person pays excessive attention to sensations that are not directly related to the present motor program, this may lead to thought disorder as well as attentional issues. These inputs might include ideas that cause a speech program to go off course and away from its primary objective (e.g., derailment, clanging). Delusions are an attempt to provide an explanation for occurrences that have been endowed with meanings that are not suitable as a result of their incursion into consciousness. When someone has hallucinations, there is an invasion of their long-term memory by elements that are mistakenly regarded as coming from the outside.

An Overview with Some Remarks

An disturbance in a person's cognitive processing is described as the foundation for the schizophrenic symptoms in the first four different theories. Disorganized thought and extraordinary sensations or perceptions (that are justified in a delusional fashion and/or form hallucinations) are the results of cognitive slippage, a lack of cognitive collaboration, parasitic foci, and hypersalience, all of which either existing schema functional production (in speech, affect, activity), or produce lodging reactions of withdrawal and passivity. These models do not make an effort to explain anatomical structures localized disruptions in schizophrenia; rather, they postulate that the dysfunction results from problems in the fundamental circuitry of the brain, which is essentially the same throughout all cortical regions. These problems may include abnormalities in neuronal density, neurological organization, or irregular communication between cells as a result of alterations in excitatory and/or noradrenaline activity. That is, it is possible that there is an issue in one or more of the fundamental cognitive computations or operations that are carried out by the brain, which affects the information processing in many brain areas. These theories don't all offer a clear picture of how cognitive aberrations result in psychotic episodes, but they all concentrate largely on the disorder of cognitive processes at their most fundamental level. Some of these theories explain hallucinations, delusions, and other undesirable symptoms as compensatory events that develop in reaction to faults in the network.

The model proposed by Walker and Diforio does not make an effort to understand how the signs of schizophrenia originate; rather, it focuses on how enhanced dopaminergic activity may be traced back to stressors and cortisol systems that are not operating properly. Their data, on the other hand,

only comes from a small number of persons who have schizophrenia; hence, it is possible that this is not an exhaustive explanation. The subsequent models provide further anatomical information to the overall image. Even if Weinberger's and Grace's don't provide adequate conjecture regarding the shift from physiological malfunction to psychological malfunction, the others do their best to attempt to do so.

The fact that these two models do not perfectly complement one another is one of the challenges associated with them. The frontal and subcortical systems are involved in both favorable as well as unfavorable symptoms in Grace's model, however in Weinberger's model, the frontal system is designated as being related to depression indicators and the subcortical region is designated as correlating to positive symptoms. Nevertheless, there is considerable overlap, and it is probable that future models may combine parts of both of these. The initial 3 approaches of Frith, Cohen, and Gray and Hemsley—assign mental tasks to various regions of the brain and describe how these structures interact when conducting their respective functions. Frith's model assigns psychological tasks to the prefrontal cortex, while Cohen's model assigns them to the hippocampus. The last two, in particular, provide psychological models that are comparable to one another. These models examine the entrance of irrelevant inputs into the process of protecting information, which has the effect of altering purposeful behaviors. In both models, the brain structures that are shown are comparable; however, the activities of each structure as well as the particular interconnections among them are depicted differently. The effort made by these three theories to establish a connection between hypothetical psychological processes and physiological processes is what makes them significant.

We utilize the same methodology in our own model, but we hypothesize a weakness in the whole integrative capability of the brain as the origin of schizophrenia rather than combinations of localized dysfunction. According to this theory, the onset of schizophrenia is preceded by a cognitive deficit and a heightened susceptibility to stress. These impairments result in the overactivity of dysfunctional schemas, which is accountable for the positive symptoms, as well as resource sparing, which is partially responsible for the adverse symptoms. As each of these models is validated, revised, and brought up to date, and as discrepancies between them are reconciled via empirical confirmation or rejection, a more accurate picture of the present mystery that is schizophrenia will start to emerge.

The challenge that lies ahead for neurobiologists can be broken down into two main parts: determining (1) what factors truly play a part to the aetiologies of schizophrenia, as a separate abnormality or as numerous disorders, and determining (2) how these variables are related to bring about the external expressions of schizophrenia. Both of these tasks have a significant amount of ground to cover. The application of the discoveries made in neurobiology to the process of psychotherapeutic schizophrenia therapy is the challenge that lies ahead for cognitive therapists. This may be helpful in a variety of ways, including: (1) the creation of novel cognitive therapy methods based on neurophysiological results; (2) support for the use of particular, existing cognitive treatment approaches; (3) aid in selecting between alternative cognitive approaches; (4) an awareness of the possible limitations of cognitive therapy treatments; and (5) a more thorough knowledge of the intricacy of schizophrenia.

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