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Neurocognitive and social cognitive deficits in schizophrenia

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Abstract

Deficits in neurocognition and social cognition are integral parts of schizophrenia. This concept was first stated by Kraeplin which led to research in this field. There has been continuous improvement in the tools used in measuring theses deficits with inclusion of modern neuroimaging techniques recently. Research is also ongoing in the field of psychopharmacological therapies to overcome these deficits however it is the psychological therapies which seem to offer most benefit.

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Introduction

Cognition refers to the perceptual and intellectual aspects of mental functioning; it refers to the use, handling or manipulation of what is known or perceived and the ability to evaluate what is perceived in terms of what is already known. Since long it is believed that significant cognitive impairment in patients with schizophrenia become evident when the disease has become chronic and worse. But, over the last two decades, with increasing research in this field, it has become clear that cognitive impairment in schizophrenia is the rule and it starts long before the illness manifests.

History

The concept of cognitive impairment was first stated by Kraeplin when he attributed abnormalities in the frontal and temporal lobes for impairment of higher intellectual abilities and this was supported by Bleurer. This provided a strong stimulus for the use of experimental methods to provide a more specific and detailed examination of the nature of the cognitive impairment in the illness. In 1945 David Rappaport and colleagues published "Diagnostic Psychological Testing"; he noted that "these patients have greatest impairment in judgement, attention, planning ability and anticipations as well as significant difficulty in learning and abstract reasoning". David Shakow noted that patients lacked a "generalised set" that could help them in selective processing of environmental stimuli, as well as response selection. Hunt and Cofer noted that intellectual quotient of patients with schizophrenia to be lower than the normal control.[1]

The psychodynamic trend of thought at that time considered schizophrenia to be a functional disorder than organic disorder which considered the illness to be result of early childhood experiences and bad parenting. It was thought that deficits displayed in psychological testing were secondary to impaired motivation or cooperation, gross breakdown of reality testing, or disordered thought processes. However with the advent of better neuroimaging techniques, it was found that there were definite structural and functional changes in patients with schizophrenia. Enlarged ventricles, reduced hippocampal, amygdalar and temporal lobe volume were the findings in most patients. Functional magnetic resonance imaging (fMRI) showed frontal lobe hypometabolism during cognitive task.[1] Microscopic findings showed reduced neuropil. All these supported that schizophrenia has organic basis and not functional.[2]

As a result of research in this area, cognitive impairment is now considered a core symptom of the disorder. Of crucial importance is the influence of cognitive impairment in predicting patient's functional adaptation. Cognitive impairment appears to be a major predictive factor in determining a patient's ability to cope successfully with everyday activities, including vocation, social networks and living independently.[3] For this reason, efforts are being made to develop treatments aimed at enhancing cognition, as well as to identify the underlying aetiopathogenic mechanisms of cognitive impairment.

Neurocognition in schizophrenia

Neurocognition refers to the ability of understanding and knowing the world around oneself. It includes attention, perception, memory, language processing, visuospatial ability, executive function and others used to interact with and make sense of the surrounding. The seven neurocognitive areas that have been identified are: attention/vigilance, speed of processing, working memory, verbal learning, visual learning, reasoning and problem solving as well as social cognition.[4]

Vigilance and attention: Vigilance refers to the ability to maintain attention over time. A standard vigilance test used in many studies is the continuous performance test. Impairments in vigilance can result in difficulty following social conversations and an inability to follow instructions regarding treatment, therapy or work functions. Vigilance deficits are related to various aspects of outcome, including social deficits, community functioning and skills acquisition.[5,6]

Verbal learning and memory: The abilities involved in memory functioning include learning new information, retaining the newly learned information and recognising the previously presented material. In general, patients show larger deficit in learning than retention.[7] They show impairment both in their ability to immediately recall verbal material and in their ability to learn over time compared with control subjects. They are also impaired in recalling interesting verbal materials, such as stories.[8] Impairment in verbal memory is associated with social deficits in patients with schizophrenia.[5]

Visual learning and memory: This part of cognition has been found not to be as impaired as verbal memory.[9] Most test require subjects to draw figures from memory or to indicate which among an array of figures was previously presented. Visual memory has been found to correlate moderately with employment status, job tenure, psychosocial rehabilitation success, quality of life ratings but correlates strongly with functional capacity.[7]

Reasoning and problem solving: The most frequently used test for reasoning and problem solving is Wisconsin Card Sorting Test in which patient is asked to arrange cards with various numbers and colours as per different principles. Poor performance and reduced activity of the dorsolateral prefrontal cortex during performance of this test has led to further research on the hypothesis of frontal hypoactivation in schizophrenia. Patients with schizophrenia who are impaired on measures of executive functions have difficulty adapting to the fast changing world around them.[7]

Speed of processing: Many neurocognitive tests require subjects to process information rapidly, a standard test to measure this is the Digit Symbol Test of the Wechsler Adult Intelligence Test. Impairment in this cognitive function is strongly correlated with Daily Life Activities, job tenure and independent living standards in many studies. Reduced processing speed can impair ability to keep in step with the task oriented jobs that are frequently held by patients with schizophrenia. Increased response latency in social settings may hamper social relationships.[7]

Verbal fluency: Tests measuring verbal fluency measure either phonological fluency or semantic fluency. The former refers to a patient's ability to produce as many words as possible starting with a particular letter within a particular time duration and the later refers to the ability to produce words within a particular meaning based category. Patient with schizophrenia produces fewer words than normal control but also gives inappropriate examples in the particular meaning based category. Impaired verbal fluency affects social and vocational functioning by making communication difficult and awkward.[7]

Immediate/working memory: Immediate memory refers to the holding of information 'on line' for a brief period (usually a few seconds). It is measured by digit forward and digit backward test. Working memory, a term given for manipulation of immediate memory, has been described by various authors as a core component of the cognitive impairments in schizophrenia and is related with functional outcomes such as employment status and job tenure.[7]

Neurocognition and symptoms of schizophrenia: Neurocognitive deficit does not improve with remission of psychosis unlike patients with psychotic bipolar illness whose performance improves on remission of psychosis.[7]

Relation with positive symptoms: It is always assumed that the cognitive difficulties in schizophrenia are strongly correlated with positive symptoms, but studies show that cognitive dysfunction accounts only for a small amount of variance in those symptoms however they may play a causal role in the propensity for positive symptoms.[10]

Relation with negative symptoms: There has been significant correlation between cognitive impairment and negative symptoms; but due to sharing of various variables (like verbal fluency, a neurocognitive variable and poverty of speech, negative symptom which measures the speech generation by the patient) between the two, the relation is said to be modest.[7]

Formal thought disorder: Deficits in semantic memory may be the main cause of the cognition and thought disorder relation.[11] Severity of impairment of semantic fluency when compared to phonological fluency predicted the severity of formal thought disorder.[12]

Measurement of neurocognition: The measurement of neurocognition can be designed in a number of ways. The most widely used are with (a) hybrid batteries, (b) computer based batteries, and (c) the MATRICS Consensus Cognitive Battery (MCCB). Hybrid batteries include a number of different neurocognitive tests which covers a number of domains and the number of tests within each domain is controlled by the investigator and is free to vary across studies. The origins of the hybrid battery can likely be traced to the Halstein-Reitan neuropsychological battery.[4] Computer based batteries have gradually become more popular as seen by the development of number of batteries over the last decade: Cambridge Automated Neuropsychological Battery, MicroCog, Neurobehavioral Evaluation System, WebNeuro, IntegNeuro, CogState, Cogtest, Mindstreams, Computerised Multiphasic Interactive Neurocognitive Dual Display. The advantages are administration and scoring of individual test within each battery is automated, thus standardising the procedure and reducing human error, allows greater precision that involve measurement of reaction time; however there are disadvantages also like difficulty in adapting tests to measure fine motor drawing skills such as visual learning tests.[4] Continuing with MATRICS, the National Institute of Mental Health (NIMH) funded another initiative called the Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS) which uses sophisticated experimental manipulation and neuroimaging techniques with the purpose of increasing the specificity of measurements in clinical trials for rapid advances in the treatment of the cognition and disability in schizophrenia.[13]

Social cognition and schizophrenia

Social cognition has been defined as "the ability to construct representations of the relation between oneself and the others, and to use those representations to guide social behaviour".[14] Social cognitive operations typically include perceiving, interpreting and generating responses to the emotions, intentions and dispositions of others. Problems in social cognition such as misperceptions and unexpected reactions to and from other people, can adversely affect functioning across different domains. There is recent increase in interest and research in social cognition as neuroanatomical association has been found with this neural network composed of the prefrontal cortex, fusiform gyrus, superior temporal sulcus and amygdala are involved in processing of social cognition. Secondly non-social cognition though involved in social functioning cannot explain 40 to 80% in functioning. Evidences suggest independence of social cognition from other aspects of cognition as individuals with frontal or prefrontal cortex show impaired social behaviour and functioning despite retaining intact cognitive skills.[15]

Domains of social cognitions studied in schizophrenia

The consensus building workshop sponsored by NIMH to integrate and guide research in social cognition has suggested five domains of social cognition.[16]

Emotional processing: It refers to the aspect of perceiving and using emotion to facilitate adaptive functioning. "Emotional intelligence" defined in one of the model of emotional processing as a set of skills that combines emotion and cognition. The model is comprised of four emotional processing components, including identifying, facilitating, understanding and managing emotions.[4]

Social perception: Social perception refers to a person's ability to judge social cues from contextual information and communicative gestures, including awareness of the roles, rules and goals that typically characterise social situations and guide social interactions. In social perception tasks, participants process nonverbal, paraverbal and/or verbal cues to make inferences about complex or ambiguous social situations.[17,18]

Social knowledge: It refers to the awareness of the roles, rules and goals that characterise social situations and guide social interactions. It requires awareness of which social cues occur typically in specific social situation (i.e. social perception) and how one is supposed to respond to them. This area has been less studied and overlaps with social perception.[4,17]

Attributional bias: Attributional style refers to how individuals characteristically explain the causes for positive and negative events in their lives, it can be external personal attribution (causes attributed to other people), external situational attributions (causes attributed to situational factors) and internal attributions (causes due to oneself). This aspect of social cognition has been studied in schizophrenia research to understand the psychological mechanisms of persecutory delusions and paranoid beliefs. Individuals with persecutory delusions may tend to blame others rather than situations for negative events, an attributional style known as 'personalising bias'.[4]

Theory of mind: The theory of mind also called mentalising involves the ability to infer intentions, dispositions and beliefs of others. Processes associated with the theory of mind involve the ability to understand false beliefs, hints, intentions, humour, deceptions, metaphor and irony. There are two levels of mentalising ability. The first level refers to automatic-preconceptual phenomena that specify a primitive understanding of another person's mind. It is based on early imitation, action and emotion recognition. The second level of

mentalising is conceptual and voluntary. It is based on intentionality, empathy and higher depths of reasoning.[4,19]

Table 1. Domains of social cognition assessed in schizophrenia[4]

Domain	Representative tasks
Emotional processing	Facial Emotion Identification Voice Emotion Identification Test Penn Computerised Neurocognitve Battery The Awareness of Social Inference Test Mayer Salovey Caruso Emotional Intelligence Test
Social perception	Profile of Non-Verbal Sensitivity Social Cue Recognition Test
Social knowledge	Situational Features Recognition Test Schema Comprehension Sequencing Test - Revised
Attributional bias	Attributional Style Questionnaire Internal, Personal and Situational Attributions Questionnaire Ambiguous Intentions Hostility Questionnaire
Theory of mind	False Belief Stories False Belief Picture Sequencing Hinting Task Reading the Mind in the Eyes Test

Cognition and functional outcome: Cognitive impairments have been found to predict self-care, social functioning, community living skills and employment, cross sectionally and longitudinally. These deficits are better than positive symptoms for predicting functional outcome. Several studies have found that impairments in different domains of cognition are associated with distinct functional outcomes: attention and vigilance with social functioning; memory and verbal learning with social, occupational and independent living; executive function with independent living; processing speed with employment.[20] One meta-analysis found that social cognition was more strongly associated with community functioning than neurocognition, with the strongest associations being between theory of mind and functional outcomes.[21]

Interventions

Pharmacological approaches: Drugs used to treat schizophrenia namely typical antipsychotics and anticholinergics should be rationally used as they are known to cause cognitive impairment. Early reports of amelioration of cognitive impairment with the use of atypical antipsychotics were from studies which were found to be flawed. However recent randomised control trials appear to support the notion that atypicals do have some beneficial effect in cognition, at least relative to typical even when the confounding factor like extra pyramidal side effect (EPSE) of typical antipsychotics are nullified with low dose of typical.[10,22] What has not been established is the dosage and the time required to establish a positive effect on cognition with atypicals. However it requires great deal of investigation in view of modest effect size of improvement in cognition with atypicals.[23] However the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) trial did not find any significant difference in improvement of neurocognition noted with low dose moderate potency antipsychotic perphenazine and the atypicals.[24] Though trials with cholinergic agents in small studies has not shown any improvement in neurocognition,[25,26] but the trials of these drugs and glutamatergic drugs are in the initial phase considered for adjunctive treatment for neurocognition in schizophrenia.

Psychological approaches

A number of studies have focused on modifying discrete areas of cognitive dysfunction to more comprehensive programmes which attempt to change a wide range of cognitive and social functioning deficits. Cognitive remediation aims to improve cognitive impairments and cognitive rehabilitation addresses the social, occupational and cognitive deficits and an attempt to improve overall functioning of the individual.[27] Cognitive remediation studies in schizophrenia have centred around three areas: testing the feasibility of modifying selected areas of cognitive dysfunction,[28] testing the generalisability of treatment effects to other domains of functioning (cognitive, socioeconomic functioning),[29] and identifying those cognitive deficits that limit the ability of schizophrenia patients to acquire new skills and abilities.[30]

Comprehensive programmes of cognitive remediation

1. Integrated Psychological Therapy (IPT) has been designed to improve the functioning of person with schizophrenia along multitude domains ranging from fairly elementary cognitive processes to more complex aspects of social behaviour. Treatment consists of five subprogrammes: cognitive differentiation, social perception, verbal communication, social skills and problem solving skills.[27]

The explicit cognitive subprogram (cognitive differentiation) addresses a variety of cognitive abilities, such as attention and conceptualisation abilities. Activities are run in a group, in which training is didactic. This method of training provides social contact that may also boost social functioning. This therapy has been subjected to rigorous evaluation; although most patients show some improvement in cognitive ability, the specific improvements differ between studies and depend on the level of experimental control.[31]

2. Cognitive Remediation Therapy (CRT) is a term describing different methods of teaching "thinking skills" although it has special significance when it focuses on those cognitive skills affecting people with schizophrenia to a larger extent such as memory and attention.[32] CRT objectives include increasing the capacity and efficiency of cognitive functions; teaching global and transferable cognitive schema to guide response; improving meta cognition; increasing meta cognition, generalising of skills and use of social support.[33] The program consists of three modules: Cognitive Shift Module, Memory Module and Planning Module. Evidence of its efficiency is variable and seems to depend on the specific components of training that are used in each case.[34]

3. Cognitive Enhancement Therapy (CET) is a comprehensive, developmental approach to the remediation of social and non-social cognitive deficits in schizophrenia. It seeks to facilitate the development of adult social-cognitive milestones (such as perspective taking and appraisal of one's social context) by shifting thinking from reliance on effortful, serial processing to a "gistful" and spontaneous abstraction of social themes.[35]

CET works with the idea that the primary aim of the intervention is to achieve two basic skills: the first, really more perceptive, which seeks to adequately assess stimuli and social contexts; the second, more cognitive in nature, refers to the embracing of flexible forms of thinking that allow the presence of multiple alternatives as information sources (divergent thinking), the anticipation of possible consequences of the response and the appreciation of the points of views of others.[36] CET is a program directed at people with stable schizophrenia and it aims to improve neurocognitive skills and social cognition.[34]

Compensatory rehabilitation programmes

The aim of these programmes is to overcome cognitive deficits to improve broader aspects of functioning by making use of help in the surroundings to train behaviour that may be of interest.[37]. Programmes include-

1. Errorless learning: The principle involves the elimination of trial and error approaches to learning. In training, subjects begin with very easy discriminations, do not experience failure and task difficulty is increased extremely gradually.[38]

2. Cognitive adaptation training: It is an evidence based treatment using environmental support such as signs, checklist, alarms, and the organisations of belongings to bypass cognitive problems and improve target behaviours and functional outcomes.

Training programmes using computers

Gradior, RehaCom and the Neuropsychological Educational Approach to Rehabilitation (NEAR) focus on attention skills rather than problem solving ones. These programmes are based on individual needs, give immediate feedback, allow the use of various reinforcement methods and also monitor learning process. These programmes aim to rehabilitate functions such as attention, perception, memory, calculation, language, logical thinking, spatial orientation, visuomotor/visuoconstructive abilities etc. The patients are regarded as learners aiming for independent living.[34]

1. Gradior, is a cognitive training system designed by the INTRAS Foundation (Research and Treatment in Mental Health and Services). The program allows direct interaction between the user and the computer, which manages the evaluation and the neurocognitive training. It is aimed at people with brain injuries, dementia, neuropsychiatric disorders with brain damage and mental illness or retardation.[34]

2. RehaCom is a computer program consisting of different modules with different levels of difficulty and with a sufficient number of options to ensure that a patient is only working with skills that at that moment are relevant to him/her. Additionally it gives specific feedback to detect errors and develop strategies.[34]

3. NEAR was created by Medalia *et al*.[39] and is based on training techniques that are intrinsically motivating, developed within educational psychology and designed to make the tasks enjoyable and compelling. Training includes participating in cognitive exercises with a computer where various cognitive skills are embedded in a contextualised format. This program has demonstrated good results.[40,41]

Conclusion

Cognitive impairment is a core feature of schizophrenia and a determinant of functional outcome. The utility of available antipsychotics is limited and there is a strong need for research effort in this field in order to improve outcome other than remission of psychosis. "We should study schizophrenia in terms of its constituent syndromes and dimensions – as well as the patient's psychological and social background - and choose the right combination of cognitive, behavioural, skill-based, family-based, milieu-based and other approaches in tackling the problems faced by an individual patient".[42] In order to address cognitive impairments in schizophrenia, the field of neurocognitive research encompasses understanding of schizophrenic deficits and supports the emergence of intervention. A careful assessment and clinical understanding of the individual,

the nature of their disorder and the impairments is crucial to the effectiveness of the interventions and rehabilitation.

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