Buckshey Award

Evaluation of Theory of mind (ToM) deficit in schizophrenia as a trait marker and its correlation with executive function

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Abstract : *Objective of the study was to assess the theory of mind (ToM) deficit in Schizophrenic patients, in acute phase and in maintenance phase and compare with normal healthy controls and find out its correlation with executive function. A cross sectional study was conducted on patients admitted in emergency ward and on maintenance treatment during follow up (n=35). Patients (acute and maintenance phase) were diagnosed as per ICD 10 criteria, separately by two consultants. In maintenance phase patients who do not have any acute relapse in last one year and stable on medication were taken (n=15). A comparison group (n=30) was selected from relatives of patients admitted in emergency ward. The theory of mind tasks and executive function test (trail making A and trail maki B) were administered on all subjects .The data was analyzed using descriptive & inferential statistics including t test, chi square test, Pearson correlation and standardized effect size. The ToM is severely compromised in schizophrenic patients, more in acute phase than in maintenance phase. Reciprocity, deception, third order false belief and first order false belief task are most affected. ToM deficit correlated with executive function whether the patient is in acute phase or maintenance phase. ToM deficit is more significant in acute phase suggesting ToM to be a state marker. ToM deficit was associated with executive function.*

Keywords: *Theory of mind, Executive function, Schizophrenia*

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INTRODUCTION

The Theory of mind (ToM) refers to the *ability to attribute mental states (such as thoughts, beliefs, desires and intentions) to people (yourself and others).*[1] ToM is recently evolved and finely tuned skills, which depend on a high degree of biological, psychological and sociological integration and is a core social cognition skill, which is required to manage our social relationships, including recognition of social signals, emotion processing, attention, working memory and decision making.[2] Mirror neurons and spindle cells provide a cellular basis for our ToM.[3,4] Frith offered a comprehensive theory, with different types of ToM skills impairment accounting for the different symptom groups.[5] Today there is considerable evidence for impaired ToM in schizophrenia in all symptom groups, most impaired in disorganization symptoms .[6,7] However, further work is needed to clarify the relation between ToM impairments, symptomatology and other cognitive domains in the disorder.[8]

People in remission also demonstrated ToM deficits, suggesting *ToM deficits as a marker of schizophrenia*. Recent evidence suggests that, contrary to Frith's original hypothesis, ToM

impairments in schizophrenia may be both a trait and state deficit, present (to some degree) in remitted patients as well as in those with active symptoms. This indicates the potential importance of focusing on ToM in the rehabilitation of all schizophrenic patients, whether they are symptomatic or not.[9,10]

The associations between ToM and other neurocognitive functions is a controversial issue.[11,12] It is well established that individuals with schizophrenia perform poorly on executive tasks, with mounting evidence that impairments are particularly associated with the presence of positive or negative behavioural signs.[13,14] Few models propose that poor performance on ToM tasks in healthy and clinical populations reflects executive dysfunction.[15-17] Many studies, concurred in showing that ToM ability continued to predict that an individual had schizophrenia, rather than being a healthy control, once executive function was controlled.[18-25] Bora et al. suggest that, before concluding that there is a trait related ToM impairment in schizophrenia, more careful research is needed to investigate ToM abilities and the influence of other cognitive deficits in symptom free patients.[26] Besides IQ, other cognitive abilities like executive functions and verbal memory impairment can influence ToM impairment in schizophrenia.[27]

This study is a pioneer work in Indian context to evaluate the ToM deficit in schizophrenic patients. We evaluated ToM deficit in schizophrenic patients and correlate ToM deficit with cognitive functions, because sufficient evidence does not exist to show or refute a correlation between the two. Whether ToM deficit is a state or trait marker of schizophrenia is also controversial, to address this issue, our study evaluated ToM deficit both in acute patients and patients on maintenance treatment.

The objective of present study was to assess the theory of mind (ToM) deficit and executive function in schizophrenic patients (acute phase and maintenance phase) and compare with healthy controls. Further, we explored correlation between ToM deficit and executive function.

METHOD

A cross sectional study was conducted on patients admitted in emergency ward and on maintenance treatment during follow up (n=35) at psychiatric centre, SMS Medical College, Jaipur, India. Patients in acute (n=20) and maintenance (n=15) phase, were diagnosed as per ICD 10 criteria, separately by two psychiatrist. In maintenance phase patients who were stable on medication for at least last one year were taken. A comparison group was selected from relatives of patients admitted in emergency ward.

For schizophrenic group patients should have been literate enough to understand the nature of the test were taken. In acute phase subgroup patients were taken as soon as they became cooperative and stable enough to understand the nature of the test. In maintenance subgroup, patients maintained on drugs on o.p.d. basis, not relapsed in last one year of follow up were taken. In control group bystanders of admitted patients in emergency ward, of either sex, literate enough to understand the nature of the test were taken. Unwilling, Illiterate patients, patient with primary diagnosis of depression and any co-morbid psychiatric disorder, patients with any chronic physical illness, patients with any developmental disorder, organic brain disorder or substance dependence were excluded from both the groups.

The subjects were explained about the study and informed and written consent was taken from subjects and accompanying primary caregiver of the patient. Subjects in maintenance phase were interviewed immediately after their registration at OPD, psychiatric centre, SMS Medical College, Jaipur. Those cases in which patient or caregiver

were in hurry to return home or office and could not stay for interview, arrangements were made to interview them at an alternative time. By standers of admitted patients were interviewed after second day of admission of their patient.

The interview was semi-structured and all information was recorded in a specially designed pro forma. Further, theory of mind picture story task, trail making A, trail making B was applied to all the subjects.

Theory of mind picture story task developed by Dr.Martin Brune of University of Bochum, Germany. Each story has 4 pictures which the subject is to arrange into a logical sequence. Subjects are then asked a short series of questions. A simple scoring system is then applied. Questions are framed to evaluate the various ToM tasks (1st order belief, 2nd order belief, 3rd order belief, reality, reciprocity, deception, cheating).

Trail making test was used to assess executive function. This task requires a subject to 'connect-the-dots' of 25 consecutive targets on a sheet of paper or computer screen. Test has two versions: A, in which the targets are all numbers (1,2,3, etc.), and B, in which the subject alternates between numbers and letters (1, A, 2, B, etc.). The goal of the subject is to finish the test as quickly as possible, and the time taken to complete the test was noted.

Statistical analysis: Mean, SD and SEM were used for descriptive purpose. Student's t test and chi-square test is applied to compare the various Sociodemographic profile and theory of mind (ToM) task in different groups and subgroups. Pearson Correlational is applied to find relation between ToM deficit and cognitive function. Standardized effect size (Cohen's *d*) was calculated.

RESULTS AND DISCUSSION

Findings of the study are shown in the table 1-5

Table-1

Comparison of ToM task and ToM deficit between schizophrenic patient and control group

ToM task	Group	Mean	S.D.	*P*	t (df)	Cohen's *d*
1st order falsebelief	case	1.8	0.9311	o.ooo	-6.445 (63)	1.61
	control	2.933	0.2537			
2nd order falsebelief	case	0.7429	1.094	0.003	-3.148 (63)	0.78
	control	1.533	0.8996			
3rd order falsebelief	case	0.5143	0.8869	o.ooo	-5.228 (63)	1.31
	control	1.8	1.095			
Reality	case	1.229	0.8075	0.006	-2.845 (63)	0.71
	control	1.733	0.5833			
Reciprocity	case	1.886	0.9322	o.ooo	-4.303 (63)	1.07
	control	2.733	0.5833			
Deception	case	1.314	0.9933	o.ooo	-0.5480 (63)	1.36
	control	2.467	0.6288			
Cheating	case	1.257	0.8521	0.002	-3.207 (63)	0.80
	control	1.833	0.5327			
ToM deficit	case	29.63	12.86	0.001	3.374 (63)	0.77
	control	21.07	8.675			

Table-2

Comparison of ToM task and ToM deficit between acute phase schizophrenic patient and control group

ToM task	Group	Mean	S.D.	*P*	t (df)	Cohen's *d*
1st order false belief	acute	1.8	0.9515	0.000	-6.229 (48)	1.80
	control	2.933	0.2537			
2nd order false belief	acute	0.5	0.8885	0.000	-3.999 (48)	1.15
	control	1.533	0.8996			
3rd order false belief	acute	0.3	0.4702	0.000	-5.765 (48)	1.66
	control	1.8	1.095			
Reality	acute	1.05	0.7592	0.003	-3.105 (48)	1.04
	control	1.733	0.5833			
Reciprocity	acute	1.8	1.056	0.000	-4.019 (48)	1.16
	control	2.733	0.5833			
Deception	acute	0.95	1,05	0.000	-6.393 (48)	1.85
	control	2.467	0.6288			
Cheating	acute	1.15	0.8751	0.001	-3.441 (48)	0.99
	control	1.833	0.5327			
ToM deficit	acute	33.4	11.74	0.000	4.965 (48)	1.23
	control	21.07	8.675			

Table-3

Comparison of ToM task and ToM deficit between maintenance phase schizophrenic patient and control group

ToM task	Group	Mean	S.D.	*P*	t (df)	Cohen's *d*
1st order false belief	maintenance	1.8	0.9411	0.000	-6.222	1.72
	control	2.933	0.2537			
2nd order false belief	maintenance	1.067	1.28	0.163	1.4121	0.45
	control	1.533	0.8996			
3rd order false belief	maintenance	0.8	1.207	0.008	-0.2791	0.88
	control	1.8	1.095			
Reality	maintenance	1.467	0.8338	0.218	-1.249	0.39
	control	1.733	0.5833			
Reciprocity	maintenance	2	0.7559	0.000	-3.598	1.14
	control	2.733	0.5833			
Deception	maintenance	1.8	0.6761	0.002	-3.271	1.03
	control	2.467	0.6288			
Cheating	maintenance	1.4	0.8281	0.039	-2.132	0.67
	control	1.833	0.5327			
ToM deficit	maintenance	24.6	12.92	0.207	1.281	0.34
	control	21.07	8.675			

Table-4

Comparison of executive function between schizophrenic patients (acute/maintenance) and control group

Comparison group	Test	Mean	S.D.	*P*	t (df)	Cohen's *d*
Case/ control	Trail making A	127.7	72.4	0.000	4.360 (63)	1.08
		68.4	18.89			
	Trail making B	237	111.3	0.000	4.752 (63)	1.18
		133.5	45.87			
Acute/ control	Trail making A	142.1	86.52	0.000	4.528 (48)	1.31
		68.4	18.89			
	Trail making B	237.4	126.2	0.000	4.134 (48)	1.19
		133.5	45.87			
Maintenance/ control	Trail making A	108.6	43.42	0.000	4.362 (43)	1.38
		68.4	18.89			
	Trail making B	236.4	92.02	0.000	5.035 (43)	1.59
		133.5	45.87			

Table-5

Correlation between ToM deficit and executive function in schizophrenic patients (acute/maintenance) and control group.

	N	Test	Pearson Correlation	Significance(2-tailed)
Cases	35	Trail making A	0.563	0.000
		Trail making B	0.590	0.000
Acute phase	20	Trail making A	0.548	0.012
		Trail making B	0.583	0.007
Maintenance phase	15	Trail making A	0.458	0.065
		Trail making B	0.624	0.013
Control	30	Trail making A	0.467	0.009
		Trail making B	0.612	0.000

We found a statistically significant difference of theory of mind (ToM) deficit, between schizophrenic patients (acute and maintenance phase both) and healthy controls (p=0.001). The mean ToM deficit in acute phase patients was 33.4 (SD 11.74). The mean ToM deficit in acute phase patients is more than one standard deviation higher than for healthy controls and is highly significant ($p < 0.001$). The mean ToM deficit in maintenance phase was 24.6(S.D.=12.92), the ToM deficit is higher than healthy controls (mean=21.06)but is not statistically significant

(p=0.207). When ToM deficit was compared in acute patients and patients on maintenance, there was statistically significant difference between the two indicating less ToM deficit in maintenance phase as compared to acute phase.

The significant ToM deficit in schizophrenic patients and control was in accord with finding shown in previous studies. [7,12,27] Compromised ToM in schizophrenic patients makes them more vulnerable to develop positive, negative and disorganized symptoms. Patients with ToM deficit, instead of taking beliefs as subjective representations of reality, equate their representations with reality and may therefore have difficulty distinguishing between subjectivity and objectivity and maintain false beliefs in the form of delusional convictions. Moreover, a neglect of other persons' social signals and putative intentions may lead to a breakdown of communication and eventually formal thought disorder. Furthermore, schizophrenia patients who have difficulties in experiencing their behaviour as the result of their own intentions may interpret their actions as being under alien control. Presence of significant ToM deficit in acute phase but not in maintenance phase indicate that ToM deficit is related only to acute phase or exacerbation of schizophrenia and is not a trait marker. Our result was in support of Frith and his colleagues' finding that patients who were in remission (i.e. symptom-free) were unimpaired compared with normal controls, but was contradictory to some studies, who find a significant difference in remission and healthy controls.[5,8,28,29] Bora. et al. used the different criteria for remission , they defined remission as being out patient and/or inpatient just before discharge and authors here described maintenance as patient having no acute relapse in last one year.[27]

Schizophrenic patient group (acute and maintenance) scored less than healthy controls in all individual ToM tasks – first order false belief (ffb), second order false belief(sfb), third order false belief(tfb), reality, reciprocity, deception and cheating. This difference is statistically significant in all individual ToM tasks. The worst affected tasks were first order false belief (ffb), third order false belief (tfb), reciprocity and deception, all having P<0.001, followed by cheating (p=0.002), second order false belief (p=0.003) and reality (p=0.006). When acute phase schizophrenic patients group was compared to healthy controls on individual ToM tasks, acute phase patients scored less on every task and difference being statistically significant. First order false belief, second order false belief, third order false belief, reciprocity and deception being most severely impaired (all having p<0.001) followed by cheating (p=0.001) and reality (p=0.003). When maintenance phase schizophrenic patient group was compared to healthy control group on individual ToM task, the maintenance phase schizophrenic patient group scored less on every task and the difference being statistically significant in all except two tasks (second order false belief and reality). In this subgroup also first order false belief and reciprocity is severely impaired (p<0.001), followed by deception (p=0.002), third order false belief (p=0.008), cheating (p=0.039), second order false belief (p=0.163) and reality 0.218).

These results indicates that patient's ability to hold a false belief of another person (first order false belief, third order false belief) is impaired the most ,he is unable to detect the other person's thinking and misinterpret them leading to conviction of his /her false beliefs (delusions). As patient cannot pretend the intention of other person, he cannot distinguish between his friends and enemies and behaving like enemies with friends and vice versa thus explaining reciprocity cheating and deception tasks also being worst affected. As the complexity of the task increases the deficit in doing it also increases this also applied to our results except one the first order

false belief (ffb) is being more severely affected than sfb and tfb. Reality task are least affected.

There was deterioration in executive function test, trail making test-A (TMT-A) and trail making test-B (TMT-B) in schizophrenic patients group compared to healthy control group and difference is statistically significant ($p<0.001$). The decline in executive function was also statistically significant in acute phase schizophrenic patients ($p<0.001$) and maintenance phase schizophrenic patients ($p<0.001$) compared to healthy controls.

In schizophrenic group the positive correlation between ToM deficit and executive function was found for TMT-A ($r=0.563$; $p<0.001$) and for TMT-B ($r=0.590$; $p<0.001$). ToM deficit and executive function were also correlated positively in acute phase schizophrenic patients ($r=0.548$ for TMT-A and $r=0.583$ for TMT-B), maintenance phase schizophrenic patients ($r=0.458$ for TMT-A and $r=0.624$ for TMT-B) and even in healthy controls ($r=0.467$ for TMT-A and $r=0.612$ for TMT-B). The correlation is statistically significant in all except one, for TMT-A in maintenance phase schizophrenic patients group ($p=0.065$). There is positive correlation between ToM deficit and executive function irrespective of acute or maintenance phase of schizophrenia, thus indicating that ToM is associated with executive functions and is not totally independent variable. This is in contrast to previous studies which states that ToM is independent variable and can predict presence of schizophrenia even when control for executive function.[27]

To conclude, the ToM is severely compromised in schizophrenic patients, more in acute phase than in maintenance phase, thus suggesting ToM deficit to be a state marker rather than a trait marker for schizophrenia. Reciprocity, deception, third order false belief and first order false belief task are most affected, explaining the development of positive , negative and disorganized symptoms of schizophrenia. ToM deficit is dependent on executive function whether the patient is in acute phase or maintenance phase. Future research on correlation of ToM deficit with symptomatology and other cognitive functions and symptoms could give more promising results.

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