Original article

Dysfunction in interhemispheric inhibition and enhancement in patients with schizophrenia

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Background The aberrant pattern of interhemispheric cooperation among patients with schizophrenia has been reported in several studies. However, the two major components of interhemispheric cooperation activities including the mutual inhibition and enhancement between the two hemispheres among this group of patients is unclear.

Methods Thirty patients with schizophrenia and twenty-eight healthy age-, sex- and education-matched controls were administered, and the mutual inhibition and enhancement between the two hemispheres were examed by a modified picture-word Stroop test and attention span test, using a three-visual-field presentation tachistoscope.

Results ① Picture-word Stroop test: In both groups, the reaction time (RT) on the Stroop picture-word congruent figures was significantly longer than that of the Stroop picture-word incongruent figures ($P<0.001$); the error rate of the middle visual field (MVF) was higher than that of the left visual field (LVF) ($P<0.05$). Between the patients and controls, no significant differences were found on the Combined Stroop Effect ($P>0.05$); However, the error rate on the MVF was higher in the patients than in the controls ($P<0.05$). ② Attention span test: The LVF and right visual field (RVF) attention span for both groups were as much as half of that on MVF. The MVF attention span among the patients was significantly less than that of the controls ($P<0.01$); However, the LVF and RVF attention span in the patients did not differ significantly from that of the controls ($P>0.05$). Interhemispheric enhancement was significantly decreased in the patients compared with the controls ($P<0.05$).

Conclusions Interhemispheric cooperation including interhemispheric inhibition and enhancement was decreased in the patients with schizophrenia, which may relate to the neuropsychological dysfunction in the patients with schizophrenia.

Keywords: *Schizophrenia interhemispheric inhibition interhemispheric enhancement Stroop effect Attention span*

Interhemispheric cooperation has been shown to be involved in many tasks. For example, interhemispheric cooperation is utilized in performance on a task involving judgment of actual Chinese words and pseudowords[1]. The information received by either hemisphere can be transferred to and integrated by the other hemisphere even among split-brain patients[2]. Based on investigations on two split-brain patients and one right-hemispherictomy patient, Guo argued that the interhemispheric cooperation consisted of mutual inhibition and enhancement between the two hemispheres[3]. The interhemispheric mutual inhibition serves to maintain independent information processing in the two hemispheres by inhibiting information processing from the opposite hemisphere. The interhemispheric enhancement involves the activation of both hemispheres through sharing information between the two hemispheres. The hypothesis that schizophrenia is associated with anomalies of interhemispheric cooperation has gained support from several studies. Morphological abnormalities in the corpus callosum[4,5] and callosal information transfer deficits[6] in patients with schizophrenia have been reported. When performing a task involving activation of the frontal lobe, patients with schizophrenia did not show normal increase in interhemispheric coherence between anterior brain regions[7]. Moreover, when processing linguistic information, patients with schizophrenia displayed significant disorganization in information processing between the two hemispheres[8-10]. However, these studies[4-10] which have reported the dysfunction in interhemispheric cooperation among patients with schizophrenia neglected

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sub-dividing the cooperation functions as suggested by Guo[3]. Therefore, we here conducted a manual Stroop picture-word test and an attention span test using the three-visual-field presentation tachistoscopic technique to explore the interhemispheric mutual inhibition and enhancement function among patients with schizophrenia.

SUBJECTS AND METHODS

Subjects Thirty neuroleptic treated in-patients (15 men and 15 women) were recruited at Beijing Hui Long Guan hospital from January 2001 to June 2001. The inclusion criteria included: ① met DSM-Ⅳ diagnostic criteria for schizophrenia[11], ② 18 to 45 years old, ③ right-handed[12], ④ naked eyesight or rectified eyesight were 1.0 or above, and ⑤ Wechsler IQ score was higher than 80. The exclusion criteria included: ① comorbid mental illness, ② history of alcohol or addictive substance abuse, ③ history of neurological illness, hypertension, diabetes, or serious brain damage (loss of consciousness), or ④ had received electro-convulsive therapy (ECT) in the last year. Among these patients, the average age was (31 ± 7) years old, the education level was (12.1 ± 2.1) years, the mean Wechsler IQ score was (102.2 ± 10.5), the average age of first onset was (23 ± 5) years, the illness course ranged from 0.5 to 23 years. Sixteen patients were diagnosed as paranoid type, twelve patients were diagnosed as undifferentiated type, one was residual type, and one was hebephrenic type. The positive score of the Positive and Negative Syndrome Scale (PANSS) was 10.9 ± 4.7, the negative score was 16.7 ± 6.2, the general score was 25.3 ± 6.7, and the total score of the PANSS was 53.0 ± 14.9.

Twenty-eight healthy controls (14 men and 14 women) were included. The inclusion criteria and the exclusion criteria were the same as those in the patients except that there were neither personal nor family history of psychosis nor abnormal perceptual experiences in the controls. Among these controls, the average age was (31 ± 7) years old, the education level was (12.3 ± 2.0) years, the mean Wechsler IQ score was 111.4 ± 8.1. There was no statistically significant difference between patients and controls on age and education levels, but the Wechsler IQ scores were significantly higher in the controls than that in the patients ($t = 3.698$, $P < 0.001$). All the subjects were consented to participate in this study, and were paid for their participation.

Methods Using a three-visual-field presentation tachistoscope, we performed the manual Stroop picture-word test (Experiment 1) and the attention span test (Experiment 2) for all participants in a quiet and sunshine-proof laboratory environment. The sequences of the two experiments were balanced, i.e. Experiment 1 was performed in 15 patients and 14 controls first and Experiment 2 was conducted in the rest subjects first. Subjects sat 57 cm in front of a computer screen with their eye height level to the center of the screen. The stimuli were run by the DMDX software using the computer in a pseudo-random sequence-the stimuli were presented in the same randomized sequence to all subjects. After a 480 ms warning tone, a blue cross "+" was located at the center of the screen and remained for 2s as the fixation point before the initiation of the stimulus. Subjects were required to maintain fixation on the central blue cross whenever the blue cross was presented. Prior to formal test, each subject practiced many times until he/she could perform the task smoothly.

Stroop picture-word test. This test was to investigate the interhemispheric inhibition function by evoking the interference between the two hemispheres[3]. The stimulus consisted of a circle 30 mm in diameter or a square 30 mm on each side, inside of which was a Chinese characters "fang" (meaning "square" in Chinese) or "yuan" (meaning "circle" in Chinese). There were four combined picture-word figures in all (Fig. 1). The figures were approximately 3° visual angle in width and height. The background was white, and the figures were black. When the figures were presented on middle visual field (MVF), the figure's center was superimposed on the center of the screen. When the figures were presented on right visual filed (RVF) or left visual field (LVF), the figure's center was on a level with and the innermost edge was 3°visual angle to the center of the screen. Each stimulus (figure) remained for about 66.7 ms. Subjects were asked to judge the outside picture as quickly and accurately as possible. They were instructed to press the mouse as the response to the modality (i.e. pressing left button as square and right as circle), which enabled the reaction time (RT) and response (true or false) to each trial to be recorded automatically by the computer. The maximum period allowed judging a figure was 3 s. If the subjects pressed the mouse or did not make a judgment within 3s, the next stimulus would be presented automatically. Each figure was presented in each visual field (RVF, MVF, and LVF) eight times, thus making 96 (4 * 3 * 8) trials in total. Ninety-six trials were divided into 3 blocks, with 32 trials in each block. After each block, subjects had a 1 min break. Prior to the formal test, subjects were asked to name the outside picture and read the inside word correctly.

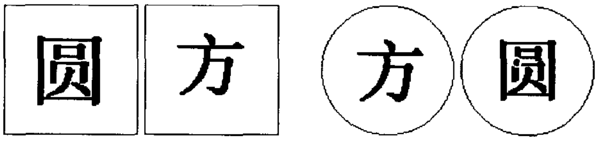

Fig. 1 Picture-word figure of Stroop test stimuli
图 1 字图 Stroop 效应刺激图形

Interested indices: ① Reaction Time (RT): the average time from the presentation of stimulus to accurate judgment of the stimulus. A longer RT indicated longer period to make an accurate judgment. ② Combined Stroop Effect (CSE): CSE = $RTs_{incongruent\ figures} - RTs_{congruent\ figures}$[13]. The CSE represented extra time needed in making an accurate judgment for picture-word incongruent stimuli compared with those for picture-word congruent stimuli. A longer CSE meant larger interference existed in picture-word incongruent condition in the subjects. ③ Error rate: error rate = (total number of errors/total number of trials) × 100%. A higher error rate meant reduced function of inhibition interference. All indices were measured in each visual field: MVF, LVF, RVF, and in total.

Attention span test. In this test, subjects were required to provide the number of randomly distributed black dots, so as to measure the interhemispheric enhancement function[3]. The stimulus consisted of many black dots 1.4 mm (approx. 0.14° visual angle) in diameter, which were distributed randomly in a 2.6° visual angle black pane on a white background (Fig. 2). For presentations in the MVF, the number of black dots ranged from 5 to 9, and the pane's center was superimposed on the center of the screen. For presentations on the RVF or LVF, the number of black dots ranged from 2 to 6, and the pane's center was on a level with and the innermost edge, which was 3° visual angle to the center of the screen. Each stimulus remained 130ms, and subjects were asked to provide the number of black dots as quickly and accurately as possible. Subjects were instructed to report the number of the black dots inside the pane orally. At the same time, the numbers were wrote down by the participants and the button was pressed to start the next stimulus. The same number of black dots were presented 8 times in each visual field, comprising 120 (5 × 8 × 3) trials in total. One hundred and twenty trials were divided into 3 blocks, with 40 trails in each block. After each block, subjects had a 1 min break. Prior to the test, all subjects were asked to count black dots from 1 to 10 correctly to demonstrate their ability of counting.

Interested indices: ① Attention span. Spearman Computing was used to calculate the attention span on each visual field. ② The interhemispheric enhancement function and each of the two hemisphere's cooperative competence which was proposed by Guo[3]. As shown in Fig. 3, the attention span of the three visual fields was located in an orthogonal coordinate. The data from the MVF was superimposed on the axis Y, and the data from RVF and LVF was located in I and II quadrant respectively. The values came from the three visual fields that form a triangle. The value of cosγ reflected the degree of interhemispheric cooperation, while that of cosα and cosβ reflected the cooperative competence of left or right hemisphere, respectively. When the vector of the RVF or LVF approached to even superimpose on axis X, the greater the value of cosγ is, which indicated a lower interhemispheric mutual enhancement cooperation. On the other hand, when the data from the RVF or LVF approached to even superimpose on axis Y, the smaller the value of cosγ was, which indicated better interhemispheric enhancement cooperation. At the same time, the greater the value of cosα or cosβ was, the higher the cooperative competences of the left or right hemisphere was[3].

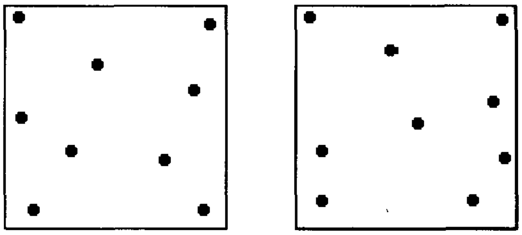

Fig. 2 Black dots in a pane used in attention span

图2 注意广度实验刺激图形

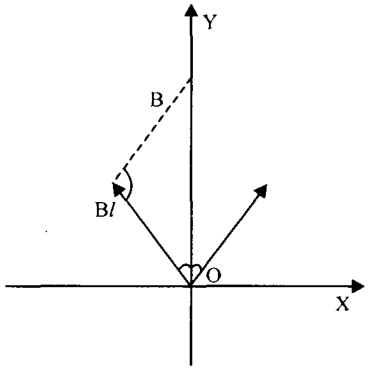

Fig. 3 A sketch map for how to measure interhemispheric cooperation. Br was moved parallel to the broken line in II quadrant to form a triangle.

图3 大脑两半球协同功能向量计算方法示意图。右视野(Br,左半球)和左视野(Bl,右半球)注意广度向量数据分别放在I和II象限,中间视野数据与Y轴重合。将Br平行移动到虚线的B处构成一个三角形。

Statistical analysis Data analyses were conducted using SPSS 10.0. Pearson's correlation analysis, Multivariate ANOVA, independent and paired t-tests were conducted for normally distributed data, and non-parameter tests such as Spearman's rank correlation analysis, Mann-Whitney-Wilcoxon rank sum test, and Wilcoxon sign rank test were conducted for non-normally distributed data.

RESULTS

Stroop picture-word effect Non parametric tests were employed due to the data for error rate was not normally distributed. The data for the patients and the controls were analyzed together. The Spearman's rank correlation of error rate and RT did not reach statistical significance ($r_s=0.22$, $P=0.09$), which indicated that the speed/accurate trade-off strategy was not employed by the subjects. The stimuli was divided by picture-word congruent and incongruent condition. In LVF, the RT for picture-word incongruent condition was (834.32 ± 162.54) ms, significantly longer than that for picture-word congruent condition [(796.82 ± 151.26) ms, $t=4.71$, $P<0.001$]. In MVF, the RTs for incongruent and congruent conditions were (811.99 ± 149.83) ms and (788.96 ± 144.84) ms, respectively ($t=3.217$, $P=0.002$). In RVF, the RTs for incongruent and congruent conditions were (825.07 ± 152.68) ms and (798.40 ± 143.77) ms, respectively ($t=3.17$, $P=0.002$). The results indicated that the Stroop effect still existed in each visual field in the present manual Stroop picture-word test.

Comparison of error rates and CSEs between the two groups

Among all the patients and controls, the IQ score was inversely correlated with RTs ($r=-0.33$, $P<0.05$), but the association of IQ score and CSE ($r=0.19$, $P=0.16$) or error rate ($r_s=-0.08$, $P=0.57$) did not reach statistical significance. Therefore, IQ score would be entered as a covariate while the analysis related to RT was performed. The total RT of the patients [(868.16 ± 150.22) ms] was significantly longer than that of the controls [(741.27 ± 91.16) ms, ($F=8.28$, $df(1, 55)$, $P=0.006$)]. The CSE in LVF, RVF, and MVF was computed respectively to investigate the interference effects among patients and controls. There was no statistically significant difference in the CSEs between patients and controls in LVF, RVF, and MVF (the values of F were 2.88, 0.395, 0.39, respectively; all Ps >0.05. See Table 1). Contrary to our hypotheses, however, the CSEs for MVF was significantly less than that for LVF ($t=-2.698$, $df=57$, $P=0.009$) among all subjects as a whole.

Compared with the controls, the total, LVF, MVF, and RVF error rates were significantly higher in the patients with schizophrenia (Z-values were 3.89, 2.77, 2.44, 3.03, respectively, see Table 1). Among all the subjects including the patients and controls, the error rate on MVF was 0.00% (Q_R: 0.00%, 6.25%), and the error rate on LVF was 0.00% (Q_R: 0.00%, 3.13%). Wilcoxon signed ranks test revealed that the error rate on the MVF was significantly higher than that on LVF ($Z=1.99$, $P<0.05$). The total error rates and total CSE did not correlate significantly among all the subjects as a whole ($r_s=-0.12$, $P=0.38$).

Comparison of attention span and the interhemispheric enhancement cooperation for the two groups As shown in Table 2, the attention spans in the LVF and RVF were about half of that in the MVF in both of the patients and controls, which implied that the interhemispheric mutual enhancement cooperation was involved in this task[3]. The results of MANOVA showed that there was a statistically significant main effect of group (schizophrenics vs. controls, $F=3.44$, $P=0.02$), but no significant interaction of group by gender or a main effect of gender. The attention span in MVF was significantly less in schizophrenics than controls ($F=8.68$, $P<0.01$), however this did not hold true in neither the LVF nor RVF ($F=0.013$, $P=0.91$; $F=0.01$, $P=0.92$. See Table 2).

In order to explore the interhemishperic enhancement function, further analyses were conducted as suggested by Guo[3]. The data of 6 controls and 5 patients did not form a triangle, as the sum of attention span in the LVF and RVF was less than that in MVF among these subjects. After excluding there subjects, the data of the remaining 22 normal controls and 25 patients were analyzed. As shown in Table 2, the results of MANOVA revealed that, compared with the normal controls, the value of cosγ was higher and the value of cosα was less in the patients with schizophrenia significantly ($F=4.21$, $P<0.05$; $F=5.54$, $P<0.05$). There was no statistically significant difference on cosβ between the two groups ($F=2.18$, $P=0.15$).

Table 1 Comparison of error rates and CSEs for patients and controls

表1 患者组与正常组错误率(%)及CSE的比较

Groups 组别	n 例数	Error rate 错误率(%) 中位数(四分位数) $M(Q_R)$: Total error rate 总错误率	LVF 左视野	MVF 中视野	RVF 右视野	CSE($\bar{x}\pm s$): LVF 左视野	MVF 中视野	RVF 右视野
Patients 患者组	30	2.61(1.04, 6.25) 1)	3.13(0.00, 6.25) 1)	3.13(0.00, 6.25) 2)	3.13(0.00, 7.03) 1)	46.2±76.0	20.4±70.9	27.8±81.2
Controls 对照组	28	1.04(0.00, 0.08)	0.00(0.00, 0.00)	0.00(0.00, 3.13)	0.00(0.00, 2.35)	30.6±32.4	21.8±31.8	24.8±37.0

1) Compared with control group, by Mann-Whitney-Wilcoxon rank sum test, $P<0.01$; 与对照组比较,经 Mann-Whitney-Wilcoxon 秩和检验, $P<0.01$

2) Compared with control group, by Mann-Whitney-Wilcoxon rank sum test, $P<0.05$; 与对照组比较,经 Mann-Whitney-Wilcoxon 秩和检验, $P<0.05$

Table 2 Comparison of attention span and interhemispheric enhancement cooperation

表2 患者组和正常组注意广度和大脑两半球互补协同功能比较 ($\bar{x} \pm s$)

Groups 组别	n[1)] 例数	MVF attention span 中视野注意广度	LVF attention span 左视野注意广度	RVF Attention span 右视野注意广度	Interhemispheric enhancement (cosγ) 两半球协同	Left brain enhancement (cosα) 左半球协同	Right brain enhancement (cosβ) 右半球协同
Patients 患者组	30	7.32 ±0.64[2)]	4.31 ±0.86	4.16 ±0.80	-0.39 ±0.31[3)]	0.81 ±0.12[3)]	0.84 ±0.08
Controls 对照组	28	7.81 ±0.63	4.29 ±0.67	4.18 ±0.80	-0.58 ±0.31	0.89 ±0.09	0.88 ±0.09

1) The sample size for calculating interhemispheric enhancement cooperation is 25 for patients and 22 for controls; 计算协同能力时患者组和对照组的例数分别为25和22

2) Compared with control group, by MANOVA, $P<0.01$; 与对照组比较,经多元方差分析,$P<0.01$

3) Compared with control group, by MANOVA, $P<0.05$; 与对照组比较,经多元方差分析,$P<0.05$

There were no significant differences on error rates, RTs, CSEs, attention span, and interhemispheric enhancement between 16 patients with paranoid schizophrenia and the remaining 14 patients. Further analyses were not conducted due to the small sample size ($n=16$ vs. $n=14$) and limited statistical power.

DISCUSSION

The results in the Stroop picture-word test revealed that, among all the subjects, the RTs for the picture-word incongruent condition were significantly longer than those for the congruent condition in every visual field and the error rate on the MVF was higher than that on the LVF. It indicated that the interhemispheric interference and mutual inhibiting activation was evoked by the present manual Stroop picture-word test. The result of the higher MVF error rate among the patients with schizophrenia than that of the controls indicated that the interhemispheric inhibition function was reduced among patients.

In the classic Stroop color-word test, subjects were asked to make a judgment of color and ignore the word information. The Stroop Effects referred to phenomena of the RT and the error rates for color-word incongruent condition were longer and higher than those on color-word congruent condition[13,14]. Phillips[13] used a three-visual-field presentation of the Stroop color-word test to study interhemispheric interference in schizophrenics. In the Stroop picture-word test, the color information was substituted by picture and such a paradigm was regarded as involving the two hemispheres more counterpoisedly[14], for it was believed that word information processing was RVF / left hemisphere (LH) advantaged and picture information processing was LVF / right hemisphere (RH) advantaged[2,3,14]. Stimulus presented in the MVF would allow for information processing to occur in both the left and right hemispheres simultaneously, thus allowing the evocation of interhemispheric interferences and interhemishperic inhibition activation[3]. Guo[3] reported that when processing information with a linguistic distractor, LVF/RH performed better than that of MVF.

The present study aimed to investigate whether the CSE and the error rate on MVF among patients with schizophrenia were higher than those among controls, and to compare the interhemispheric inhibition function between the patients and the controls. Contrary to our original hypotheses, however, the CSEs on MVF were less than that on LVF. Discrepant results of the visual fields effect on CSEs have also been reported by Phillips[13]. The divergence of our results from the extant literature may come from methodological and sample differences. First, the stimuli utilized in our study were different, a manual picture-word test was used in the present study, while the oral report Stroop color-word test was used in the previous studies. The manual picture-word test could decrease the influence of color-naming and phonic processing which were regarded as left hemispheric advantaged. It resulted in a reduced CSE, as the values of the CSEs were approximately 20 to 40 ms, significantly less than the approx. 100 ms reported by Phillips[13]. Second, the subjects were different from that in previous studies. All subjects in Phillips' study were male, while half of the subjects in our study were female. Therefore, gender differences might cause the differences between our study and the previous study.

Although the interference effect was still present in the manual Stroop picture-word test, the difference in reaction times may not be an ideal indicator to measure the degree of the interhemispheric inhibition. An alternative to reaction time is the measurement of accuracy, which has been argued by Narr[9] to be a more sensitive measure of functional laterality and interhemispheric cooperation. Accuracy is also commonly used to assess interference level, especially when the tachistoscopic paradigm is employed[14]. In the present study, the higher error rate in MVF for both groups indicated that interhemispheric interference was evoked by the manual Stroop picture-word test. Interhemispheric inhibition is necessary to perform such a task[2]. In the present study, higher MVF error rate among patients implied that the interhemispheric *inhibition* was reduced. Similar and contrary result have been obtained by Lohr[8] and Narr[9] respectively.

Some evidences suggest that only patients who show interhemispheric lexicality priming[9] display difficulty inhibiting irrelevant information received by opposite hemisphere among schizophrenic patients. It may give a suitable explanation to the reduced interhemispheric inhibition among schizophrenic patients. Phillips,[13] has reported a reduced interhemispheric *interference* among the patients. In his study, an oral report color-word Stroop paradigm comprising word-reading was used. There is evidence suggesting that bilateral advantage is related to the processing of such linguistic information[1,10]. Therefore, the reduced interhemispheric interference in color-word Stroop test among schizophrenics may be a reflection of a deficit in interhemispheric information transference among this group. It has been identified in the past and expounded upon elsewhere by Barnett[6].

The results revealed that the attention span on the MVF was less in the patients with schizophrenia compared with the controls. Additionally, a higher value of $\cos\gamma$ and a lower value of $\cos\alpha$ were found among the patients. The findings indicated that the interhemispheric enhancement function and the left hemisphere's cooperative competence were decreased in the patients with schizophrenia. Mutual enhancement between the two hemispheres is another important component of the interhemispheric cooperation[2,3]. Performing a cognitive task, such as those measuring attention span, requires spatial searching and organizational abilities that are regarded as right hemispheric advantaged in addition to counting abilities that are regarded as left hemispheric advantaged[3]. Because the stimuli were presented on MVF, better performance would be expected as the two hemispheres were involved simultaneously[2]. Therefore, the decreased attention span on MVF among patients with schizophrenia implied the decreased interhemispheric enhancement. The greater value of $\cos\gamma$ on patients with schizophrenia (-0.39 vs. -0.58) indicated that the data from lateral (left and right) visual field ran opposite from axis Y and approached to axis X, which implied that the interhemispheric enhancement cooperation was decreased in the patients. Furthermore, the smaller value of $\cos\alpha$ among patients (0.81 vs. 0.88) indicated that the vector of RVF /LH ran opposite from axis Y and approached axis X, which implied that the enhancement competence of the left hemisphere was impaired among the patients. These findings were similar to Barnett's study[10] that schizophrenic patients showed a lack of bilateral advantage in a lexical-decision task.

The interhemispheric cooperation is essential for performing on higher-level cognitive tasks[1-3]. Although the interhemispheric cooperation dysfunction have been reported previously[6-10], the division of the cooperation activation has been ignored. The present study suggested that schizophrenia was associated with impaired interhemispheric inhibition and enhancement cooperation. Therefore, given these findings, it is essential to examine interhemispheric cooperation at a more exact and accurate level. The anatomical and functional abnormalities of the callosum[4-7] may be the physiological basis for the decreased interhemispheric inhibition and enhancement cooperation among these patients, still, future studies should integrate the use of fMRI or other advanced technologies to measure the physiological bases for interhemispheric cooperation.

There were several limitations in the present study. First, we utilized Guo's[3] novel measurement to assess the degree of interhemispheric enhancement cooperation. However, data obtained from 6 normal controls and 5 patients were not applicable, given that their coordinates did not form a triangular shape. Thus, a new index to assess the interhemispheric cooperation should be established which is suitable to more subjects. Second, due to the little sample size, we did not compare the interhemispheric cooperative function between patients with paranoid schizophrenia and non-paranoid schizophrenia. We were also unable to test the relationship between the interhemispheric inhibition cooperation and other clinical characteristics such as symptom, course, and age of first onset. Therefore, more subjects need to be included in the future study.

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精神分裂症患者的大脑两半球互抑与互补协同功能障碍

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【摘要】 **背景** 此前有研究结果表明精神分裂症患者大脑左右两半球之间的协同功能下降;但临床神经心理研究结果提示大脑两半球的协同活动有互抑与互补两种形式。本研究旨在进一步探讨精神分裂症患者的大脑两半球互抑与互补两种协同功能是否均受损。**方法** 30例精神分裂症患者和28名健康对照纳人研究,采用Stroop字图实验和注意广度实验分别测试大脑两半球的互抑及互补协同功能,用三视野速示法将图形伪随机呈现在左、中、右视野。实验中被试眼睛与电脑屏幕正中注视点保持水平,距离屏幕的距离为57 cm。左、右侧视野的图形位置为水平距离正中点3°~6°视角,中间视野图形的位置为正中左右各1.5°视角,所有图形距离屏幕正中水平线上下各1.5°视角。①Stroop字图实验的图形为直径30 mm的圆形或边长30 mm的正方形,内有一个汉字“方”或“圆”。每次图形呈现的时间为66.7 ms,要求被试又快又准地用按鼠标键的方式判断图形是圆形还是方形,计算机自动记录被试在每个图形判断上的正确与否以及反应时。②注意广度实验的图形是边长26mm的方框内散布着2~9个直径1.4 mm的黑圆点,每次图形呈现的时间为130 ms。要求被试报告图形中黑点的数目,由主试记录被试每次报告的结果。用斯皮尔曼分配法计算每个被试各个视野的注意广度。**结果** ①Stroop字图实验:所有被试字图不一致图形的反应时长于字图一致图形($P<0.001$),中视野错误率高于左视野($P<0.05$)。患者组中视野错误率高于对照组($P<0.05$)。②注意广度实验:所有被试左、右视野的注意广度为中视野的1/2。患者组中视野注意广度较对照组差($P<0.01$),患者组大脑两半球互补协同功能及左半球的协同能力比正常组差($P<0.05$)。**结论** 精神分裂症患者大脑两半球互抑及互补协同功能均受损,患者左半球的互补协同能力下降。

【关键词】 精神分裂症 大脑两半球互抑协同 大脑两半球互补协同 Stroop效应 注意广度

【中图分类号】 R749.3; R395.1 【文献标识码】 A

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