請仔細閱讀下面這篇期刊，再回答所列出的問題

題目：The relationship between visual-perception and attention in Chinese with schizophrenia
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Patients with schizophrenia exhibit pervasive neuropsychological deficits, in which impairment in visual-perceptual function is common. Visual-perceptual function is a broad concept including spatial function (perception, estimation and orientation), visual function (construction, organization and recognition), closure and color estimation and discrimination. Such impairments could have considerable negative impacts on schizophrenic patients' general cognitive functioning because intact visual-perceptual function is the foundation of normal processing and organization of the enormous inputs from the visual world. Furthermore, visual-perceptual organization is a prerequisite for rapidly accessing semantic memory. Dysfunction of the ability to generate representations of segmented visual information could lead to reduced integration of visual stimuli with relevant stored memory.

To understand the nature of visual-perceptual function as experienced by people with schizophrenia, knowledge of perceptual organization and attention, and their interrelations is needed. Deficits in attention have been identified as core deficits of schizophrenia since Kraepelin in 1919. Recent studies have suggested that there are several distinct components of attention. Four commonly identified components are sustained attention, selective attention, switching attention and attentional control processing.

This study sought to verify if people with schizophrenia showed visual-perceptual difficulty. Furthermore, despite the well-established findings showing impairments in attention and perceptual organization among patients with schizophrenia, there is a paucity of research devoted to understand the interrelationship between attention and visual-perceptual organization. We therefore speculated that visual organization, and spatial perception and orientation of people with schizophrenia would be predicted by different components of attention, namely sustained attention, selective attention, switching attention and attentional control processing.

## 1. Methods

### 1.1. Participants

A total of 94 individuals participated in the present study: 47 belonged to the clinical group and 47 to the normal control group. All the participants gave their written informed consent prior to participation. The demographic and clinical characteristics of the clinical and normal populations are presented in Table 1.

Table 1. Demographic and clinical characteristics of patients with schizophrenia and normal controls

| Variable | Patients (*n*=47) | | Controls (*n*=47) | | | |
|---|---|---|---|---|---|---|
| | ***M*** | **S.D.** | ***M*** | **S.D.** | ***F*** | ***p*** |
| Nonverbal IQ (TONI-3) | 22.77 | 5.90 | 30.06 | 3.25 | 55.167 | <0.001 |
| Years of education | 11.24 | 3.24 | 11.19 | 2.36 | 0.123 | 0.726 |
| Age (years) | 37.83 | 9.36 | 62.85 | 9.62 | 163.35 | <0.001 |
| BDI | 5.66 | 3.13 | 1.43 | 0.95 | 78.77 | <0.001 |
| Age of onset (years) | 28.74 | 8.40 | NA | | | |
| Illness duration | 9.01 | 7.68 | NA | | | |

| Variable | Patients (*n*=47) | | Controls (*n*=47) | | | |
|---|---|---|---|---|---|---|
| | ***M*** | **S.D.** | ***M*** | **S.D.** | ***F*** | ***p*** |
| SAPS | 4.47 | 5.90 | NA | | | |
| SANS | 7.11 | 8.04 | NA | | | |
| No. of admissions | 1.85 | 1.38 | NA | | | |

TONI-3=Test of Nonverbal Intelligence-3, BDI=Beck Depression Inventory, NA=not applicable, SAPS=Scale for Assessment of Positive Symptoms, SANS=Scale for Assessment of Negative Symptoms.

The two groups were matched in terms of gender composition (21 men and 26 women in each group, $\chi^2(df=1)$, $p<0.01$, ns). However, we could not match the two groups in both the dimensions of age and education. When we matched in terms of education [$F(1,92)=0.12$, $p=0.73$], the two groups were different in terms of age [$F(1,92)=163.35$, $p<0.01$]. The normal controls would be of a much higher level of education if they were matched to the clinical population in terms of age. Given that both age and education bear a strong relationship to intellectual ability, in order not to confound our findings due to the inclusion of too many variables, we decided to use the scores in the Test of Nonverbal Intelligence-3 (TONI-3) for the two groups [$F(1,92)=55.17$, $p<0.01$], which estimates nonverbal intellectual ability, in further data analysis in this study. As depression has a significant impact on cognitive function, we used the Beck Depression Inventory-II (BDI) to ascertain the degree of depression felt by our participants. The two groups had significantly different scores in the BDI [$F(1,92)=78.770$, $p<0.01$].

### 1.1.1. Clinical group

Forty-seven schizophrenic patients with well-regulated symptoms were recruited from an outpatient clinic in a public hospital in Hong Kong. These schizophrenic patients underwent a clinical interview as part of a comprehensive medical screening by an experienced mental health professional. The patients had to meet the Diagnostic and Statistical Manual of Mental Disorders-IV Test Revised (DSM-IV-TR) criteria for schizophrenia in order to be included. Patients with organic brain disorder, a history of severe head trauma, or a significant history of drug abuse or alcoholism were excluded from the study.

The mean duration of illness was 9.01 (S.D.=7.68) years and the average age of onset of illness was 28.74 (S.D.=8.40) years. The mean number of hospitalizations was 1.85 (S.D.=1.38). The severity of the clinical syndrome at the time of examination was assessed using the Scale for Assessment of Negative Symptoms (SANS) and the Scale for Assessment of Positive Symptoms (SAPS). All the patients were on antipsychotic medication at the time of the study. We did not control for patient medication because those patients who agreed to be withdrawn from their medication were not representative of the clinical population being studied. Though visual-perceptual function among patients with schizophrenia seems to be responsive to drug treatment, Killan et al. (1984) concluded in their study that psychotropic medication and the regime of its administration did not affect performance in cognitive and perceptual tests for schizophrenic patients in any specific manner. Joober et al. (2002) studied the neuropsychological profile of patients with schizophrenia. Neuroleptic responder and neuroleptic-nonresponder patients, representing the two extremes of the neuroleptic response spectrum, were examined and compared with healthy controls. Although they performed significantly below the level of the normal subjects, the two groups did not differ from each other in terms of visual-spatial ability.

### 1.1.2. Normal control group

Forty-seven controls engaged in full-time employment, matched for education level (in years), were recruited. Controls with a previous history of psychiatric illness, or drug or alcohol dependence were excluded. All the participants were administered the Test of Nonverbal Intelligence to assess their current intellectual functioning, and the BDI to detect signs and symptoms of depression.

1.2. Instruments

All the participants completed a comprehensive battery of neuropsychological tests selected to assess intelligence, selective attention, sustained attention, auditory attention span, switching attention, the attention control process, visual-perceptual organization ability and visual-spatial perception ability. The tests were administered and scored by trained research assistants who were undergraduate students majoring
in psychology or psychology graduates. The battery of tests was administered within 7 days of rating the symptoms.

1.2.1. Digit Vigilance Test (DVT; Lewis and Kupke, 1977)

The DVT, which is a subtest of the Lafayette Clinic Repeatable Cognitive Perceptual-Motor Battery, was used to assess sustained attention.

1.2.2. Stroop Test (Stroop, 1935)

The Stroop Test has been a common measure of selective attention (e.g. Amador et al., 1998). A previously validated Chinese translation of the Victoria Version of this test was used in the present study (Lee and Chan, 2000).

1.2.3. Symbol Digit Modalities Test (SDMT; Smith, 1982)

SDMT is a measure of switching attention. Following the standard administration procedure, both the written and the oral formats of the test were administered (Brouwer and Zomeran, 1994; Lezak, 1995). However, only the score of the oral format was used as a measure of the switching attention in the present study. This decision was based on the findings of Ponsford and Kinsella (1992) which suggested that the oral format of the SDMT was a better measure for switching attention.

1.2.4. Color Trails Test (CTT; D'Elia and Satz, 1989)

The CTT is an analogue of the Trials Making Test (TMT) from the Halstead-Reitan Battery in which letters from the English alphabet are substituted with colors (Cohen, 1993; D'Elia et al., 1996). Attentional control processing was assessed by the CTT (D'Elia et al., 1996).

1.2.5. Judgment of Line Orientation Test (JLOT; Benton et al., 1983)

The JLOT was used as a test of spatial perception and orientation. It consists of 5 practice and 30 test items. Each item comprises a pair of lines printed on one page. The subject is required to match the spatial orientation of these pair of lines with the corresponding ones from an array of lines shown on the previous page.

1.2.6. Hooper Visual Organization Test (HVOT; Hooper, 1983)

The HVOT, on the other hand, was used as a test of visual-perceptual organization. It consists of 30 drawings of common objects cut into several parts randomly displayed. The subject is required to conceptually rearrange the parts and name the objects.

1.3. Procedure

Each subject was administered the tests in a standardized order, on a one-on-one basis. Sustained attention was measured at the beginning of the testing. Testing was limited to 1 h and was conducted in a quiet room provided by the hospital.

1.4. Statistical analysis

The hypothesis of group difference in visual-perceptual function was tested by the analysis of covariance (ANCOVA), with visual-perceptual measurements as dependent variables and the scores in the TONI-3 and the BDI as the covariates. The hypothesis of the differential pattern of relationships between the different components of attention and visual-perceptual function was examined by multiple regression. All statistical tests were carried out using the Statistical Package for the Social Sciences (SPSS). The level of significance was set at $\alpha$=0.05.

## 2. Results

The scores of the schizophrenic patients and the healthy controls in the neuropsychological tests are displayed in Table 2.

Table 2. Comparisons of neuropsychological test scores among patients with schizophrenia and healthy controls

| Measures | Patients (*n*=47) | | Controls (*n*=47) | |
|---|---|---|---|---|
| | ***M*** | **S.D.** | ***M*** | **S.D.** |
| DVT-Total Time | 499.30 | 208.98 | 309.49 | 12.50 |
| Stroop Test (I) | 14.89 | 8.87 | 5.28 | 0.91 |
| CTT (I) | 58.28 | 45.93 | 36.58 | 7.30 |
| SDMT-Oral | 47.53 | 12.82 | 66.70 | 2.79 |
| HVOT | 19.30 | 4.74 | 22.68 | 1.51 |
| JLOT | 17.81 | 6.36 | 26.79 | 1.23 |

DST=Digit Span Test (Forward), SDMT=Symbol Digit Modality Test, Stroop Test (I)=Interference score, CTT (I)=Color Trails Test Interference Score, DVT=Digit Vigilance Test, HVOT=Hooper Visual Organization Test, JLOT=Judgment of Line Orientation Test.

To test hypothesis 1, that people with schizophrenia would show visual-perceptual difficulty, ANCOVA tests were conducted to determine the between group differences in the HVOT and the JLOT, with the scores in the TONI-3 and the BDI as covariates. The results indicated significant group differences in the HVOT [$F(1,90)=6.13$, $p=0.015$] and the JLOT [$F(1,90)=29.865$, $p<0.01$]. These findings supported our speculation that people with schizophrenia did suffer from visual-perceptual deficits as measured by the HVOT and the JLOT. The score in the TONI-3, though not in the BDI, was a significant covariate ($p=0.001$ and $<0.001$ for the HVOT and the JLOT, respectively), implying that ability measured by the TONI-3 has a significant influence on the performance in both the HVOT and the JLOT.

To test hypothesis 2, that different components of attention, namely sustained attention, selective attention, switching attention and attentional control processing, would relate to the visual-perceptual function of people with schizophrenia differently, step-wise multiple linear regression procedures were employed. The scores in the HVOT and the JLOT were used as the criterion variables. Table 3 and Table 4 provide a summary of these results.

Table 3. Summary of stepwise regression analysis for variables predicting the HVOT

| Predictors | ***B*** | **S.E.** | ***β*** | $R^2$ |
|---|---|---|---|---|
| Constant | 11.454 | 2.428 | | |
| SDMT-Oral | 0.165** | 0.049 | 0.446 | 0.199 |
| Excluded variables | | | | |
| DVT-Total Time | | | 0.263 | |
| Stroop Test (I) | | | −0.115 | |
| CTT (I) | | | −0.040 | |

**$p<0.01$

Table 4. Summary of stepwise regression analysis for variables predicting the JLOT

| Predictors | *B* | S.E. | *β* | $R^2$ |
|---|---|---|---|---|
| Constant | 7.80 | 3.474 | | |
| CTT (I) | −6.017E−02** | 0.019 | −0.434 | 0.189 |
| Excluded variables | | | | |
| DVT-Total Time | | | −0.129 | |
| Stroop Test (I) | | | 0.100 | |
| SDMT-Oral | | | 0.222 | |

** $p<0.01$.

Four variables, including the scores in the DVT (total time), the Stroop Test (interference score), the SDMT (oral version) and the CTT (interference score), were entered as predictor variables using the stepwise method. Among the normal controls, none of the four variables significantly predicted the performance in the HVOT or the JLOT ($p>0.05$). However, consistent with our speculation, different components of attention related to the performance in the HVOT and the JLOT of our clinical participants. For the HVOT, only the SDMT (oral version) significantly predicted its score ($p=0.002$), which explained 19.9% of the variance of the score in the HVOT. The other variables were not significant predictors ($p>0.05$). For the JLOT, the CTT (interference score) was the only significant predictor of performance ($p=0.002$), explaining 18.9% of the variance of the score in the JLOT.

## 3. Discussion

This study examined visual-perceptual function of people with schizophrenia and how different components of attention related to it. The findings indicated that people with schizophrenia did suffer from visual-perceptual deficits in the areas of visual-perceptual organization (measured by the HVOT), and spatial-perceptual organization and orientation (measured by the JLOT). We also observed that different components of attention related to the visual-spatial function of people with schizophrenia differently. Attentional control processing, measured by the CTT, turned out to be the best predictor of performance in the HVOT, while switching attention, measured by the SDMT, was the best predictor of performance in the JLOT. A relationship between attention and visual-perceptual function was not observed for our normal controls.

### 3.1. Visual-perceptual function

Our findings are consistent with those of previous studies. Using a task of reporting displayed lines, Place and Gilmore (1980) demonstrated that perceptual deficits in schizophrenic patients were due to a failure to organize information at an early stage of visual processing. Wells and Leventhal (1984) replicated the study with several methodological refinements, and confirmed the findings.

However, our findings contradict those of other reports. Faustman et al. (2001) evaluated the basic perceptual and visual processes in patients with schizophrenia and observed that most of the patients showed a normal range of performance in neuropsychological tests including the Right-Left Orientation Test, the JLOT and the Visual Form Discrimination Test. Also, Riley et al. (2000) found that there were no significant differences in performance in the JLOT between patients with first-episode psychosis and controls in terms of visual-spatial perception.

The discrepancy in the findings could be explained by methodological heterogeneity across studies. In our study, we included only chronic patients diagnosed with schizophrenia, whereas in some other studies, a broader spectrum of clinical participants may have been recruited (e.g. Riley et al., 2000). The degree of chronicity of the clinical participants may also affect the findings regarding the visual-perceptual function of patients with schizophrenia. For example, Riley et al. (2000) used patients with first-episode psychosis, whereas our participants had reached a more chronic stage of their illness. Sweeney et al. (1991) conducted a longitudinal study on the stability of neuropsychological deficits in schizophrenic patients, and observed significant improvement in their scores in the JLOT after 1 year (Benton et al., 1983). The discrepancy in the symptom constellation of the participants may have contributed to the variation in the research findings. Faustman et al. (2001) suggest that negative symptoms may relate to visual-perceptual function, and that the differences in the sample combination could interfere with the findings regarding the visual-perceptual function of patients with schizophrenia.

Though the JLOT and the HVOT are commonly used in evaluating the visual-perceptual function of patients with schizophrenia, the batteries of tests adopted have varied slightly across studies. Some used block design and picture completion subtests of the Wechsler Scale (e.g. Joober et al., 2002), while others used different measures of visual-perceptual function (e.g. Faustman et al., 2001). Cross-study comparisons would be more meaningful and powerful if researchers were to adopt a more unified experimental protocol.

3.2. Attention and visual-spatial function

Our findings are consistent with those of previous reports that attention and the visual-spatial function of people with schizophrenia are related. For example, Tek et al. (2002) evaluated the integrity of the perceptual system for object and spatial visual information, and the relevant working memory system after adjusting for individual perceptual performance differences. They concluded that the systems governing object and spatial visual perception, and working memory appeared to be affected differently by schizophrenia.

We observed that the attention control process is a significant predictor of visual-perceptual organization measured by the HVOT. We therefore speculated that an inability to focus on relevant stimuli and disregard irrelevant stimuli may overload the limited amount of processing capacity available (Kahneman, 1973). Furthermore, impairments in the activation and allocation of attention (Nestor et al., 1990) create further difficulty for the attention control process that may eventually affect visual-perceptual organization. On the other hand, switching attention measured by the SDMT predicts spatial perception and orientation measured by the JLOT. Considering the findings of Gold et al. (2002) that performance in the Digit-Symbol Test, a variant form of the SDMT, was also a significant predictor of functional outcomes, in terms of length of job tenure, it further suggests that spatial perception and orientation may bear an impact on the level of functioning of people with schizophrenia in the real world.

Given the fact that both attentional tasks, namely the CTT and the SDMT, predicting visual organization and orientation are timed tasks, could a generalized slowing of neurocognitive functions in people with schizophrenia limit the amount of relevant information that can be processed within a limited time frame and henceforth affect visual-perceptual functioning observed in people with schizophrenia? This speculation awaits verification in future research employing attentional paradigms that are not timed.

In summary, the findings of this study clearly indicate that visual-perceptual deficits do exist in patients with schizophrenia, which may extend beyond the domains measured in this study. Also, different attention components relate to the visual-spatial function among people with schizophrenia differently. The unique patterns of such relationships imply that different models are needed to describe specific domains of visual-spatial function and attention. Furthermore, future research efforts to understand the universality of the pattern of visual-spatial deficits across the different subgroups of schizophrenia will provide theoretical refinement of the cognitive impact of schizophrenia.

## 問題

1. 請簡要敘述本文的 (1) 研究目的 (2) 研究方法 (3) 結果 (4) 結論。 (40 分)
2. Results 的第二段第 1-2 行，請說明為何 ANCOVA 要以 TONI-3 **與** BDI 作為共變項？ (20 分)
3. 請指出 Discussion 第一段第 5-6 行的敘述 “Attentional control processing, measured by the CTT, turned out to be the best predictor of performance in the HVOT, while switching attention, measured by the SDMT, was the best predictor of performance in the JLOT.” 有何錯誤之處？(20 分)
4. 請說明本研究設計使用控制組的目的為何？(20 分)