



# Applied Short-Form WAIS-III to Explore Global Cognitive Profile of the Patients with Schizophrenia

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### Abstract

#### Background:

Schizophrenia is associated with cognitive impairment. The Wechsler Adult Intelligence Scale (WAIS) has been used extensively to assess cognitive function in schizophrenia in research and clinical practice. This study aimed to validate the short-form WAIS-III in efficiently assessing global cognitive profile of the patients with schizophrenia.

#### Methods and Findings:

Thirty-four patients diagnosed with schizophrenia were recruited from the medical centre. Each participant received the short-form WAIS-III consisting of seven core subtests. The test provided scores for VIQ, PIQ, and FSIQ, along with four secondary indexes (Verbal Comprehension, Working Memory, Perceptual Organization, and Processing Speed). The results showed that patients with schizophrenia generally had low scores in the short-form WAIS-III, especially in FSIQ, PIQ and Processing Speed index, in agreement with previous research. Moreover, the scores of four indexes from high to low were Verbal Comprehension, Working Memory, Perceptual Organization, and Processing Speed. However, no significant deficit of Working Memory index was observed in this study, which may indicate that Working Memory index was affected by illness duration.

#### Conclusions:

The short-form WAIS-III may have clinical potential for assessment of global cognitive profile of schizophrenia. Furthermore, Working Memory index needs to be taken into account when applied in rehabilitation.

#### Keywords:

Cognitive function, WAIS-III, Schizophrenia, Working memory index, Perceptual Organization

### Introduction

Schizophrenia is a functional disability of the brain. Previous studies showed that patients with schizophrenia experienced cognitive impairment, such as deteriorations in attention functions, memory, language, executive functions and

general intelligence [1-8]. Cognitive impairments in patients with schizophrenia were also known to affect their daily activities, social abilities, and community functioning [9-12]. Therefore, it is important to further investigate the cognitive impairments in patients with schizophrenia in

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order to improve their cognitive rehabilitation and to enhance their social adjustment.

The Wechsler Adult Intelligence Scale (WAIS) has been used extensively to assess cognitive functions in patients with schizophrenia for both research and clinical practices [3,13-18]. The Wechsler Adult Intelligence Scale-III (WAIS-III) has been updated from the Wechsler Adult Intelligence Scale-Revised (WAIS-R). WAIS-III includes 11 core subtests and 3 supplemental subtests. It provides three IQ scores: Full-Scale IQ (FSIQ), Verbal IQ (VIQ), and Performance IQ (PIQ), and four indexes: Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed. Verbal Comprehension index measures the ability of oral explanations and abstract concepts. Perceptual Organization index measures non-verbal thinking, such as the manipulation of designs and pictures, fluid reasoning, and spatial processing. Working Memory index measures the ability to retain information temporarily to perform a designated task. Processing Speed index measures the ability to perform given tasks quickly and efficiently based on the presented information [19]. The reliability of the Chinese version of the WAIS-III had been confirmed through a standardization study [20].

The full WAIS requires a significant length of time. Therefore, the short-form WAIS was developed. Ward et al. proposed the seven-subtest short form for the WAIS-R. The model was adopted and modified into WAIS-III [21]. Short-form WAIS-III includes the subtests of Information, Digit Span, Arithmetic, Similarities, Picture Completion, Block Design, and Digit Symbol. Sattler and Ryan found the FSIQ, VIQ and PIQ scores in the full WAIS-III and short-form WAIS-III had fairly good correlations [22]. The use of short-form WAIS-III is an efficient method to get a quick estimate of the intellectual functioning. However, studies showed that the short-form WAIS-III could efficiently estimate the VIQ, PIQ and FSIQ, but there had been little data on the short form's effectiveness in quickly evaluating performances on Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed indexes.

Previous studies found that patients with schizophrenia tend to have higher VIQ than PIQ [18,23]. In a study with 42 participants diagnosed with schizophrenia, the average IQ scores were in the low average range, indicating a

decline in performance compared to the general population [20]. Moreover, the mean scores of patients in the Verbal Comprehension and Perceptual Organization indexes were higher than the Working Memory and Processing Speed. Wilk, *et al.* also found that patients with schizophrenia were better than controls on Verbal Comprehension and Perceptual Organization but worse on Working Memory and Processing Speed [24]. Those findings indicated that patients with schizophrenia are impaired in cognitive functions: In the IQ scores, FSIQ was lower than expected, and PIQ was significantly lower than VIQ; in the index scores, the scores from high to low were Verbal Comprehension, Perceptual Organization, Working Memory, and then Processing Speed. The performance of Verbal Comprehension index was better preserved in schizophrenia, while the Processing Speed index was the most impaired.

In this study, we intent to study the three IQ scores and four index scores of patients with schizophrenia with the Chinese version of the short-form WAIS-III, with the hypothesis that their performance would be significantly impaired, especially in FSIQ, PIQ and Processing Speed index.

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## Methods

### ■ Subjects

34 patients (20 inpatients and 14 outpatients) with schizophrenia were recruited from a medical centre in southern Taiwan. Experienced senior psychiatrists made the diagnosis of schizophrenia according to the *DSM-IV* criteria. All patients had fair medical compliance and relatively stable clinical course. Exclusion criteria included severe psychosis, visual or auditory disabilities, motor system disability, a history of substance abuse, mental retardation, brain injury, stroke, delirium, dementia, amnesic and other cognitive disorders.

### ■ Examinations

The Chinese version of the WAIS-III was administered and scored according to the standardized procedures outlined in the manual [20]. Data on seven core subtests of the short-form WAIS-III (Similarities, Information, Picture Completion, Block Design, Arithmetic, Digit Span and Digit Symbol-Coding) were collected. VIQ, PIQ and FSIQ, as well as four secondary indexes (Verbal Comprehension, Perceptual Organization, Working Memory and Processing Speed) were then calculated.

**Statistical Analysis**

The demographic data was summarized by frequency distribution, percentages, means and standard deviations. The scores of IQ, indexes and subtests of the WAIS-III were shown as mean and standard deviation. The differences of the IQ and indexes scores were analyzed with paired-*t* tests and post hoc Bonferroni’s adjustments. Statistical significance was determined by  $p < 0.05$ .

**Results**

The average age of patients with schizophrenia is  $39.79 \pm 10.61$  years. The average education is  $12.06 \pm 2.77$  years. The average illness duration is  $12.65 \pm 6.37$  years. The detailed demographic data is summarized in **Table 1**.

In the patients with schizophrenia, their PIQ score was significantly lower than VIQ (paired-*t* test:  $t=6.62$ ,  $p=0.00$ , 95% confidence interval: 8.03-15.15), and the mean difference was  $11.59 \pm 10.20$ . The FSIQ, PIQ, Perceptual Organization index and Processing Speed index were lower than standard scores by at least 1 SD, and the Working Memory index was approximately lower than 1 SD (healthy population mean=100, SD=15). The scores of indexes from high to low were Verbal Comprehension, Working Memory, Perceptual Organization then Processing Speed (**Table 2**).

Analysis of the subtests, which construct the indexes, revealed that Picture Completion and Block Design subtests (Perceptual Organization index), Arithmetic (Working Memory index) and Digit Symbol-Coding (Processing Speed index) were approximately lower than standard scores at least 1 SD (healthy population mean=10, SD=3) in patients with schizophrenia. Digit span subtest was relatively preserved in the patients with schizophrenia than other subtests, especially in forward digit span (**Table 3**).

Further analysing the difference of the indexes, a significant difference within indexes was observed ( $F=6.96$ ;  $p=0.00$ ) in patients with schizophrenia. The Verbal Comprehension index was significantly higher compared to the other indexes except for Working Memory index, and there were no significant differences for each paired comparisons among the Perceptual Organization, Working Memory, Processing Speed indexes (**Table 4**). The performance of Working Memory index was better than Perceptual Organization index, though no

**Table 1: Demographic characteristics of patients.**

| n = 34                  | Mean           | SD    |
|-------------------------|----------------|-------|
| <b>Age</b>              | 39.79          | 10.61 |
| Participants (n = 34)   |                |       |
| Inpatients              | n = 20 (58.8%) | -     |
| Outpatients             | n = 14 (41.2%) | -     |
| <b>Gender</b>           |                |       |
| Male                    | n = 14 (41.2%) | -     |
| Female                  | n = 20 (58.8%) | -     |
| Years of education      | 12.06          | 2.77  |
| Age at onset of illness | 27.14          | 9.12  |
| Illness duration        | 12.65          | 6.37  |

**Table 2: Descriptive results of the indexes of the short-form WAIS-III in patients with chronic schizophrenia.**

| n = 34                  | Mean  | SD    |
|-------------------------|-------|-------|
| Verbal IQ/VIQ           | 90.41 | 15.24 |
| Performance IQ/PIQ      | 78.82 | 15.26 |
| Full-Scale IQ/FSIQ      | 84.59 | 14.99 |
| Verbal Comprehension    | 94.06 | 16.01 |
| Perceptual Organization | 83.50 | 14.86 |
| Working Memory          | 86.53 | 15.54 |
| Processing Speed        | 76.65 | 17.30 |

**Table 3: Descriptive results of the subtests of the short-form WAIS-III in patients with schizophrenia.**

| n = 34                         | Mean | SD   |
|--------------------------------|------|------|
| <b>Verbal Comprehension</b>    |      |      |
| Similarities                   | 8.62 | 3.25 |
| Information                    | 8.94 | 2.87 |
| <b>Perceptual Organization</b> |      |      |
| Picture Completion             | 7.06 | 2.67 |
| Block Design                   | 7.03 | 3.26 |
| <b>Working Memory</b>          |      |      |
| Arithmetic                     | 7.12 | 3.15 |
| Digit Span                     | 8.71 | 2.96 |
| <b>Processing Speed</b>        |      |      |
| Digit Symbol-Coding            | 5.59 | 3.23 |

statistical significance was found. The digit span subtest of the Working Memory index, the length of forward is significant higher than backward (**Table 5**).

**Discussions**

The major findings of the present study confirmed that the patients with schizophrenia had low performance on FSIQ, PIQ and Processing Speed. The performance of PIQ is significantly lower than VIQ, and the Processing Speed is the lowest of 4 indexes. The results are consistent with the past findings [9,14-17,24-27].

Further explorations the distribution of 4 indexes of short-form WAIS-III in patients with schizophrenia was not entirely consistent

**Table 4: Pairwise comparisons for the short-form WAIS-III indexes.**

| (I) index               | (J) index               | Mean (I-J) | p value <sup>a</sup> |
|-------------------------|-------------------------|------------|----------------------|
| Verbal Comprehension    | Perceptual Organization | 10.56      | 0.04*                |
|                         | Working Memory          | 7.53       | 0.32                 |
|                         | Processing Speed        | 17.41      | 0.00**               |
| Perceptual Organization | Verbal Comprehension    | -10.56     | 0.04*                |
|                         | Working Memory          | -3.03      | 1.00                 |
|                         | Processing Speed        | 6.85       | 0.47                 |
| Working Memory          | Verbal Comprehension    | -7.53      | 0.32                 |
|                         | Perceptual Organization | 3.03       | 1.00                 |
|                         | Processing Speed        | 9.88       | 0.07                 |
| Processing Speed        | Verbal Comprehension    | -17.41     | 0.00**               |
|                         | Perceptual Organization | -6.85      | 0.47                 |
|                         | Working Memory          | -9.88      | 0.07                 |

<sup>\*</sup>p < 0.05, <sup>\*\*</sup>P < 0.01; <sup>a</sup> Bonferroni's adjustment

**Table 5: Descriptive results and pairwise comparisons for forward and backward of the digit span subtest.**

| n = 34    | Mean | SD    | T value | p    |
|-----------|------|-------|---------|------|
| Lforward  | 6.06 | 1.229 | 13.32   | 0.00 |
| Lbackward | 2.96 | 1.427 |         |      |

Lforward: the length of forward (total N:8), Lbackward: the length of backward (total N:7)

with earlier findings. In previous studies, the performance of Verbal Comprehension and Perceptual Organization indexes were better than Working Memory and Processing Speed indexes. The Working Memory index is the second lowest index [14,15,17,26]. However, in present study, we found the Working Memory to be higher than Perceptual Organization and Processing Speed indexes. The Working Memory index is the third lowest index. However, our result is similar to the studies of Fujino, *et al.* [16] and Chiang, *et al.* [25]. More specifically, in the study by Chiang, *et al.* the Working Memory was 80.06 (second highest of the scores), and the average illness duration was 8.06 years [25,28]. In the study by Fujino, *et al.* the Working Memory was 88.2 (second highest of the scores), and the average illness duration was 11.8 years [16]. In the study by Michel, *et al.* the Working Memory was 84.19 (third highest of the scores), and the average illness duration was 24.71 years [17]. In the study by Galaverna,

*et al.* the Working Memory was 68.47 (third highest of the scores), and the average illness duration was 25.28 years [15]. Those findings seemed to hint that longer illness duration could be associated with a lower score of Working Memory. However, correlation analysis of our data revealed no statistical significance ( $r=0.216$ ,  $p=0.221$ ). Further investigations will be needed to verify those results.

Compared with healthy controls in Taiwan, the performance of backward digit span is more than 1 SD lower in the patients with schizophrenia, and the performance of forward digit span is within 1SD (WAIS-III manual) [20]. The forward digit span requires the participant to repeat the digits verbatim and the backward digit span requires the participant to repeat the digits in reverse order. The present study shows that patients with schizophrenia are not significantly impaired on immediate, rote memory (simple task), consistent with a previous study [28].

In summary, the present findings of patients with schizophrenia having low performance on FSIQ, PIQ and Processing Speed index in the short-form WAIS-III are consistent with previous studies [16,25]. The scores of 4 indexes from high to low are verbal Comprehension, Working Memory, Perceptual Organization, and then Processing Speed. The performance of Verbal Comprehension index is better preserved in schizophrenia. However, the Working Memory might be affected by longer illness duration. When planning rehabilitation program for patients with schizophrenia, one may need to consider our finding that longer illness duration affect certain categories of cognitive performance, such as working memory.

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