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# Development of brief versions of the Wechsler Intelligence Scale for schizophrenia: Considerations of the structure and predictability of intelligence

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## ARTICLE INFO

### Article history:

Received 27 May 2013

Received in revised form

28 July 2013

Accepted 9 August 2013

### Keywords:

Wechsler Intelligence Scale Revised

WAIS-R

Short form

Factor analysis

Multiple regression analysis

## ABSTRACT

Short forms (SF) of the Wechsler Intelligence Scale have been developed to enhance its practicality. However, only a few studies have addressed the Wechsler Intelligence Scale Revised (WAIS-R) SFs based on data from patients with schizophrenia. The current study was conducted to develop the WAIS-R SFs for these patients based on the intelligence structure and predictability of the Full IQ (FIQ). Relations to demographic and clinical variables were also examined on selecting plausible subtests. The WAIS-R was administered to 90 Japanese patients with schizophrenia. Exploratory factor analysis (EFA) and multiple regression analysis were conducted to find potential subtests. EFA extracted two dominant factors corresponding to Verbal IQ and Performance IQ measures. Subtests with higher factor loadings on those factors were initially nominated. Regression analysis was carried out to reach the model containing all the nominated subtests. The optimality of the potential subtests included in that model was evaluated from the perspectives of the representativeness of intelligence structure, FIQ predictability, and the relation with demographic and clinical variables. Taken together, the dyad of Vocabulary and Block Design was considered to be the most optimal WAIS-R SF for patients with schizophrenia, reflecting both intelligence structure and FIQ predictability.

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## 1. Introduction

The Wechsler Adult Intelligence Scale tests (WAIS, Wechsler, 1955; WAIS-R, Wechsler, 1981; WAIS-3, Wechsler, 1997; and WAIS-4, Wechsler, 2008) have been widely used for assessing intellectual functioning in clinical or research venues. The volume of the WAIS tests, however, has been a major concern among users irrespective of the editions; in healthy adults, for example, the WAIS-R and the WAIS-3 take approximately 60 and 80 min respectively (Blyler et al., 2000; Ward et al., 1987). The administration time tends to be longer for people with neurologic or psychiatric disorders (Blyler et al., 2000; Missar et al., 1994). Specifically, patients with psychiatric disorders, such as schizophrenia, exhibit a wide range of cognitive disturbances (Heinrichs and Zakzanis, 1998; Reichenberg and Harvey, 2007), and therefore, a complete administration of the WAIS may be too stressful in most occasions.

Although short forms (SFs) of the WAIS tests have been produced for each version, few attempts have been made to develop the WAIS-R SFs based on data from patients with schizophrenia. Several studies using schizophrenia samples (Allen et al., 1997; Iverson et al., 1998; Missar et al., 1994; Ryan et al., 1999; Uetsuki et al., 2004) have routinely applied the SFs produced mostly based on the normal standardization samples, with no theoretical consideration for the intellectual construct or functioning of this disease. The SFs carefully designed for schizophrenia will warrant an accurate estimation for the intellectual status of this disease.

Several approaches have been suggested on developing the SFs for patients with schizophrenia. The most popular approach, probably, is to maximize the predictability of FIQ. In this paradigm, the best SFs are decided based on correlation with FIQ (Brooker and Cyr, 1986; Kaufman et al., 1991; Reynolds, 1983; Silverstein, 1982; Ward et al., 1987) or goodness of fit to single (Ringe et al., 2002) or multiple (Blyler et al., 2000; Boone, 1990) linear regression models. Subtests with higher correlations or a greater accountability for the total FIQ variance typically constitute the SFs. Under this paradigm, a variety of SFs for healthy samples have

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been produced for the WAIS-R (Brooker and Cyr, 1986; Kaufman et al., 1991; Reynolds, 1983; Silverstein, 1982; Ward, 1990) and the WAIS-3 (Blyler et al., 2000; Ringe et al., 2002).

Another approach is to emphasize the factor structure of intelligence (Maxwell, 1959, 1960). In this framework, SFs are designed to represent the factor structure of the WAIS tests, wherein subtests intensively loading on a specific factor are chosen. Factor analytic studies on the WAIS and WAIS-R have commonly identified two dominant factors, i.e. Verbal Comprehension (VC) and Perceptual Organization (PO), and a less salient factor, Memory/Free From Distractibility (Memory/FFD) in healthy adults (Cohen, 1957a; Wallbrown et al., 1974, for the WAIS, Parker, 1983, and for reviews, Gutkin et al., 1984; Hill et al., 1985; Leckliter et al., 1986, for the WAIS-R). Although the subtest loadings on those factors varied depending on statistical techniques or target samples, generally, Vocabulary and Information yielded higher loadings on VC, while Block Design and Object Assembly did on PO, and Arithmetic, Digit Span, and Digit Symbol did on Memory/FFD (Leckliter et al., 1986).

The notion for the factor-based structure of intelligence has been prevalent since the introduction of the four indices of VC, PO, Processing Speed (PS), and Working Memory (WM) in the WAIS-3 (Wechsler, 1997). This concept has been further advanced in the WAIS-4 (Wechsler, 2008), where the traditional verbal-performance dichotomy has been replaced by the factor-based indices. This trend of re-modeling seems to have made investigators more factor-conscious on selecting subtests for SFs in the recent WAIS edition (Crawford et al., 2008; Girard et al., 2010).

Which approach should be taken for constructing the SFs for schizophrenia seems to depend on users' purposes. If just a gross estimation of overall intellectual functioning is necessary, predictability would be the first priority, and thus subtests with higher accountability for the FIQ variance would be selected for the SFs. This type of SFs may be of particular use in clinical trials or studies, where subjects are to be exposed to time-consuming neuropsychological batteries or scales other than intelligence assessment. On the other hand, if the structural equivalency of intelligence between patients and healthy adults is a major concern, factor-based SFs would suffice for the purpose. To evaluate such a qualitative aspect of intelligence, for example, would be useful in clarifying possible deterioration of intellectual organization in a subgroup (e.g. chronic, early-onset, at-risk) of patients with schizophrenia, in addition to the degradation of overall intellectual functioning.

Given the considerations noted above, the current study has adopted a joint approach in developing SFs for schizophrenia; both predictability of FIQ and intelligence structure were taken into consideration on subtests' selection for the optimal SFs.

A couple of additional issues need to be discussed. First, to produce factor-based SFs, it is important to confirm that the intellectual organization in patients with schizophrenia is relatively preserved or similar to that of healthy samples (i.e. a clear factor structure exists). To date, however, little information has been available on this issue. Allen et al. (1998) investigated factor structure of the WAIS-R in patients with schizophrenia, using confirmatory factor analysis (CFA). In this method, hypothetical factor models are assumed *a priori*, and the fitness of good to the empirical data is tested. The study reported that a three factor model best fits the patients' data, consisting of VC (Verbal Scale subtests except for Digit Span), PO (Picture Completion, Block Design, Picture Arrangement, and Object Assembly), and FFD (Digit Span, Arithmetic, and Digit Symbol). This factor structure was virtually the same with normal subjects, although a slight variation of subtests was found for the FFD. The cross-clinical equivalency of factor structure has been replicated in the WAIS-3 (Dickson et al., 2002) and other language versions (Saklofske et al.,

2000; Yao et al., 2007); four factor construction, analogous to the four indices of the WAIS-3 (VC, PO, WM, and PS), existed in patients with schizophrenia.

Results from these previous studies indicate consistency of the intelligence structure irrespective of diagnosis or the WAIS editions. Upon developing SFs, however, exploratory factor analysis (EFA), which prevails latent factors without assuming multiple models *a priori*, seems to be simpler and more effective (both statistically and theoretically) in distinguishing whether sufficiently clear and genuine structure exists in this clinical sample. To our knowledge, EFA for has been conducted on the WAIS-3 (Dickson et al., 2002), but not on the WAIS-R in patients with schizophrenia.

Another issue to be considered is the relation to demographic and clinical variables (i.e. education, age of onset, drug dose, or psychiatric symptoms). Apparently, subtests that are less affected by these variables would be desirable for the SFs. Allen et al. (1997) administered the Kaufman's 4SF (Arithmetic, Similarities, Digit Symbol, and Picture Completion) (Kaufman et al., 1991) to patients with schizophrenia, and found a significant correlation between performance on the SF and education, but not age of onset. The study also reported negative correlations between the scores of the SF and psychiatric symptoms assessed by the Bunney–Hamburg Psychosis ratings (Bunney and Hamburg, 1963). However, which subtests were strongly correlated with those variables has not been mentioned. Nor has the study addressed which psychotic symptoms (e.g. positive or negative) disturbed the execution of the subtests included in the SF (Allen et al., 1997).

Considering the above issues, the current study was conducted to develop the WAIS-R SFs tailored for patients with schizophrenia, taking simultaneous consideration over the intelligence structure and predictability for FIQ on subtests' selection (for the schematic representation, see Fig. 1). First, EFA was conducted to nominate plausible subtests for SFs, clarifying the intelligence structure in patients with schizophrenia (Fig. 1a). Second, multiple regression analysis was administered to search a model containing the nominated subtests. Third, the best combination, which represents the intelligence structure and predictability of FIQ, was identified (Fig. 1b). The relationship between the potential subtests and the demographic and clinical variables was also considered to propose the optimal SF. Finally, the strength of the SF proposed in this study was discussed in relation to cognitive domains the subtests covers.

## 2. Method

### 2.1. Subjects

Ninety patients with schizophrenia entered the study. The demographic and clinical profiles of the participants are summarized in Table 1. They were recruited from inpatients or outpatients of the Department of Neuropsychiatry University of

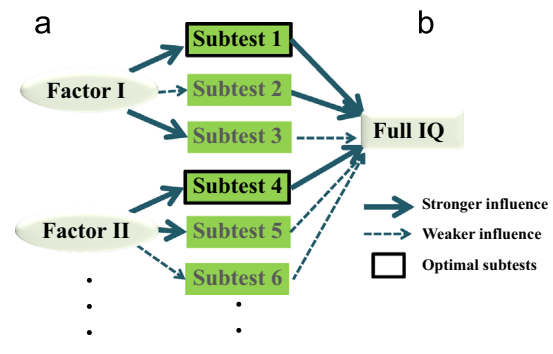


Fig. 1. Schematic pass-diagram for the current study approach (a: factor analytic approach and b: regression analytic approach).

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