



# Testing for multigroup invariance of the WISC-IV structure across France and Switzerland: Standard and CHC models<sup>☆</sup>



Isabelle Reverte<sup>a</sup>, Philippe Golay<sup>a,b</sup>, Nicolas Favez<sup>a,b</sup>, Jérôme Rossier<sup>c</sup>, Thierry Lecerf<sup>a,b,\*</sup>

<sup>a</sup> Faculty of Psychology and Educational Sciences, University of Geneva, Switzerland

<sup>b</sup> Distance Learning University, Switzerland

<sup>c</sup> Institute of Psychology, University of Lausanne, Switzerland

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## ABSTRACT

Measurement invariance of the WISC-IV factorial structure between French and Swiss samples was investigated by means of multi-group confirmatory factor analysis (MGCFA). The first sample was the French WISC-IV standardization sample described in the French WISC-IV technical manual (ages 6:0 through 16:11 years), which included 1103 children (Wechsler, 2005). The French speaking Swiss sample included 249 children ranging in age from 8 to 12 years old (124 males, mean age = 10.16, SD = 1.12 and 125 females, mean age = 10.26, SD = 1.17). Multigroup higher-order models were estimated to assess measurement invariance. In a first step, multigroup models were used to analyze the current four-factor structure. In a second step, multigroup higher-order models were conducted on a CHC-based model with five factors. For both the four-factor and the CHC-based models, results supported partial measurement invariance. Indeed, while configural and weak metric invariance criteria were met, intercept invariance was not demonstrated

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## 1. Introduction

The Wechsler intelligence scales, and more particularly the Wechsler Intelligence Scale for Children (WISC-IV), are the most used tests across the world (Bowden, Saklofske, & Weiss, 2011; Chen, Keith, Weiss, Zhu, & Li, 2010; Lecerf, Rossier, Favez, Reverte, & Coleaux, 2010). Wechsler intelligence scales have been adapted in approximately 20 nations and are employed for the assessment of intelligence (12 adaptations were done across the world for the WISC-III). To the best of our knowledge, exploratory and/or confirmatory factor analysis (EFA and CFA) supported a four-factor structure for all countries.

The French WISC-IV was adapted from the U.S. version, and showed adequate psychometrics properties in the French standardization sample. Because no specific adaptation of the WISC-IV was done in Switzerland, Swiss practitioners are forced to use the version adapted in other countries (Germany, Italy, and France). Thus, they are forced to assume that the WISC-IV measures the same psychological attributes in all groups. Although this assumption is probably justified, it still needs to be empirically tested. Thus, this paper is concerned with measurement invariance by means of Multi-Group Confirmatory Factor

Analysis (MGCFA). A prerequisite to testing measurement invariance is *configural invariance*. However, in order to determine whether the unit of measurement is equal across groups, and whether one can make comparisons of the group latent variables means, weak, strong and strict invariance were also tested.

Switzerland is a country with three linguistic regions (one German part, one Italian part, and one French part). Regarding the French part of Switzerland, there is no French-speaking Swiss specific standardization data available for the WISC-IV. The factorial structure of the WISC-IV and the normative tables developed in France are used for the assessment of French speaking Swiss children. Although France and the French part of Switzerland are very close geographically and supposedly culturally, there is no guarantee that cultural and linguistic backgrounds are strictly equivalent. However, as stated by Ortiz, Ochoa, and Dynda (2012), culture and language influence intelligence test performance, and for these authors, all tests have cultural and linguistic components. Thus, somehow, we can consider that our study raises similar issues to those of cross-cultural researches (Frisby, 2013; Hambleton & Lee, 2013). Indeed, after translating and adapting tests into multiple languages and cultures, *The International Test Commission Guidelines for Test Adaptation* emphasize that empirical evidence are needed to demonstrate that a test remains valid in a second language and culture (see [www.intestcom.org](http://www.intestcom.org); and Hambleton & Lee, 2013, pp. 179–180). In the present study, because the WISC-IV was transported from France to Switzerland, we examined the assumption that test scores would be invariant across these two countries; thus,

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\* Corresponding author at: FPSE -Psychology, University of Geneva, 40, Bd. du Pont d'Arve, CH-1205 Geneva, Switzerland. Tel.: +41 22 379 92 22.

E-mail address: [Thierry.lecerf@unige.ch](mailto:Thierry.lecerf@unige.ch) (T. Lecerf).

the issue remains the same as in cross-cultural studies: could test scores be interpreted in the Swiss–French sample in the same way as in the original French sample? In other words, is it appropriate to use the unmodified French WISC-IV with Swiss–French children, or would it be necessary to modify some subtests? Thus, like cross-cultural research, our study raised the issue of bias and equivalence (Van de Vijver & Tanzer, 2014). Therefore, testing for measurement invariance across both groups is an important issue for the clinical use of the WISC-IV in the French part of Switzerland. Measurement invariance must be examined prior to any interpretations in order to demonstrate that subtests and index scores have the same meaning for all samples (Chen et al., 2010). Without evidence of measurement invariance, similar interpretation of the WISC-IV subtests and index scores cannot be granted for French-speaking Swiss children. In sum, questions addressed by our study are similar to some guidelines published by the International Test Commission (ITC) for translating and adapting educational and psychological tests (see Hambleton & Lee, 2013, p. 179–180). For instance, by testing level of invariance (guideline I.3), we will be able to “substantiate the differences with empirical evidence” (guideline I.2), and hence to determine the amount of overlap in the constructs measured by the WISC-IV in the French and the Swiss–French samples (guideline C.2). In addition, our study will give some information about the equivalence of the WISC-IV for both groups, and will allow us to identify problematic components or aspects of the WISC-IV that may be inadequate to the Swiss–French sample (similar to guideline D.7). Thus, our study will “provide information on the evaluation of validity in all target populations (French and Swiss–French samples) for whom the adapted versions are intended” (D.8). Finally, our study will allow us to determine whether the socio-cultural and ecological contexts of the French part of Switzerland might affect performance (guideline I.4).

Currently, the interpretation of the WISC-IV is based on a four-factor structure (Verbal Comprehension, Perceptual Reasoning, Working Memory, & Processing Speed). Contemporary studies have shown that the four-factor solution provided satisfactory goodness of fit for several normative samples, like U.S. sample (Weiss, Saklofske, Prifitera, & Holdnack, 2006), Asian samples (Chen et al., 2010), French normative sample (Lecerf et al., 2010) and French speaking Swiss sample (Reverte, Golay, Favez, Rossier, & Lecerf, 2014). The first goal of this study was to investigate the measurement invariance of the current four-factor structure of the WISC-IV between a French and a French-speaking Swiss sample. Implicit is the assumption that WISC-IV scores have the same meaning for French and Swiss–French children. Thus, equivalence is assumed to hold for the factorial structure, factors patterns, and the underlying factors. As far as we know, measurement invariance of the WISC-IV scores across French and Swiss–French children has never been reported. Therefore, it is unknown whether the WISC-IV shows measurement and structural invariance across these two groups.

Even if the last revision of the WISC represents a significant revision, and is more psychometrically and theoretically grounded (Grégoire, 2009), this battery still presents some important limitations, especially concerning the relation between test interpretation and contemporary theory of cognitive abilities. Indeed, the factorial structure of the WISC-IV is not completely in line with the Cattell–Horn–Carroll (CHC) model of intelligence measurement, which is currently the consensual psychometric-based model of human cognitive abilities (Alfonso, Flanagan, & Radwan, 2005). Several studies demonstrated that CHC-based models were equally or more adequate than did the four-factor scoring structure for the U.S. sample (Keith, Fine, Taub, Reynolds, & Kranzler, 2006; Weiss, Keith, Zhu, & Chen, 2013b), for the French standardization sample (Lecerf et al., 2010) and for a French speaking Swiss sample (Reverte et al., 2014). Thus, it has been suggested that the WISC-IV subtests scores measure five CHC factors: fluid reasoning (Gf), comprehension-knowledge (Gc), visual processing (Gv), short-term memory (Gsm), and processing speed (Gs). These findings suggest

that the interpretation of the WISC-IV subtests scores could be improved by applying the CHC structure. Although CHC-based models better described the WISC-IV than did the four-factor structure for both French and Swiss children, it is unknown whether CHC measurement invariance holds for both groups. This is why measurement equivalence of CHC-based models across French and Swiss–French children was also tested in the present study. Therefore, the second main goal of this study was to investigate the measurement invariance of a five factors model based on the CHC theory.

In sum, in a first part, we tested whether the four indexes (VCI, PRI, WMI, and PSI) have the same meaning for French and French-speaking Swiss children. In a second part, we investigated whether the five CHC factors (Gf, Gv, Gsm, Gc and Gs) have the same meaning for French and French-speaking Swiss children.

## 2. Method

### 2.1. Participants

We analyzed data from two samples: French and French-speaking Swiss samples. Concerning the French Sample, the data was issued from the WISC-IV standardization sample described in the French WISC-IV technical manual (ages 6:0 through 16:11 years) and included 1103 children (Wechsler, 2005). The French-speaking Swiss sample consists of 249 children ranging in age from 8 to 12 years old (124 males, mean age = 10.16, SD = 1.12 and 125 females, mean age = 10.26, SD = 1.17). The children came from different schools of the Canton of Geneva (Switzerland). This sample was stratified according to socioeconomic status of the parents and gender. All children were in the school grade appropriate to their chronological age. The administration of the WISC-IV was done during school hours in 2 sessions of 45 min. The tests were administered individually at school. The average FSIQ of the French sample was 99.9 with a SD of 18.1 (Wechsler, 2005, p. 45), while the average FSIQ of the Swiss sample was 104.98 with a SD of 13.25.

### 2.2. Instrument

The WISC-IV is an individually administered intelligence test for children (aged from 6 to 16:11 years). The WISC-IV has 10 core subtests and 5 supplemental subtests. The 10 core subtests are Similarities (SI), Vocabulary (VO), Comprehension (CO), Block Design (BD), Matrix Reasoning (MR), Picture Concepts (PCn), Digit Span (DS), Letter–Number Sequencing (LNS), Coding (CD), and Symbol Search (SS). The Full Scale IQ is based on the sum of these 10 core subtests. The five supplemental subtests are Cancellation (CA), Picture Completion (PC), Information (IN), Word Reasoning (WR), and Arithmetic (AR). All 15 subtests of the WISC-IV were administered to the Children and were analyzed in the present study.

### 2.3. Analysis

It first should be noted that there was no missing data for the Swiss sample. Before performing the invariance analysis, a baseline four-factor model and a baseline CHC model were tested separately for French and French-speaking Swiss samples (phase 1). According to the technical manual, the baseline WISC-IV model was designed to reflect four first-order factors: Verbal Comprehension (VCI), Perceptual Reasoning (PRI), Working Memory (WMI), and Processing speed (PSI). In addition, because studies of intelligence agree upon a hierarchical model, a higher order *g* factor was included (see Fig. 1). In this model, the association between *g* and the fifteen subtests scores is mediated fully by the four first-order factors, and hence there is no direct links between *g* and the subtests scores (see also Weiss et al., 2013b). Thus, *g* is considered to be a “super-ordinate” factor (Gignac, 2006; Golay & Lecerf, 2011). Although not reported here, it should be noted that a

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