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Measuring intellectual impairment in adults. A comparison between WAIS-IV and Montreal Cognitive Assessment (MoCA)

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Abstract

The aim of the study was to compare the cognitive performances of adults with intellectual disability in two tests different in purposes, format, length, and ease of use: WAIS-IV battery for measuring full and factorial IQs, and Montreal Cognitive Assessment (MoCA) used for the evaluation of cognitive deterioration.

The two tests were administered to a sample composed of 40 adults, 27 males and 13 females, diagnosed with Mild or Moderate Intellectual Disability (age range 16-64 years, mean age 35.70).

No gender differences were detected. Results show that both the total IQ and the WAIS-IV factors are significantly correlated with MoCA score, except the Processing Speed. Verbal Comprehension is the best predictor of the impairment measured by MoCA. This result is confirmed by Multidimensional Scaling. Among the single WAIS-IV subscores only Puzzle and Cancellation show small correlations with MoCA score.

The memory functions assessed by MoCA result different from those of WAIS Working memory, factor more close to the MoCA visuo-spatial subdomain.

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Some implications for the assessment of the cognitive impairment in adults with Intellectual disability are underlined.

Keywords: Intellectual Disability; Cognitive Impairment; WAIS-IV; MoCA test; Assessment.

1. The assessment of intelligence and its impairment

The Wechsler Adult Intelligence Scale (Fourth Edition, WAIS-IV) is the most used test for measuring the cognitive abilities of adolescents and adults aged between 16 and 90 years. Since its first edition (Wechsler, 1955) the WAIS, providing a total score of IQ besides some profile scores, was conceived for assessing the level of possible mental deterioration, comparing the performance with the norms for typical development.

While Wechsler test measures the general intelligence, through a composite and comprehensive evaluation of different factors, other instruments have been devised as a quick way for detecting the presence of a cognitive decay, based on standardization in samples of persons with a diagnosis of mental deterioration.

The cognitive impairment in adults is commonly evaluated by the *Mini-Mental State Examination* (MMSE), an instrument fast to administer and easy to score, used especially for detecting early dementia. The authors (Folstein, Folstein, & McHugh, 1975) demonstrated that the MMSE correlated with the WAIS, concluding that a shorter but equally reliable measurement of an individual's cognitive status was possible, with the further advantage of easier use in cases of patients with a diagnosis of severe mental impairment.

Pauli, Daseking, Petermann and Stemmler (2017) showed that there are significant correlations between another dementia screening test (SKT) as a measure of total cognitive impairment and the WAIS-IV indexes, confirming that the cognitive decline assessed with a short screening tool reflects well the results of a test of intelligence. The results of this study suggest that in elderly the cognitive impairment begins with a reduced speed of information processing and an impaired working memory capacity.

Another test used for a quick evaluation of impairment is the MoCA (*Montreal Cognitive Assessment*; Nasreddine, Phillips, Bédirian, Charbonneau, Whitehead, Collin *et al*., 2005). It was devised to assess, particularly in Mild Cognitive Impairment or other non-dementing conditions of cognitive impairment, functions partly different from MMSE. The skills evaluated are: executive functions and abstract reasoning, visual-spatial abilities, memory, concentration and sustained attention, language (naming, verbal fluency), temporal and spatial orientation.

These tests have in common the evaluation of adults' cognitive domains, but more research is needed to understand what functions are overlapping in the different instruments and if the scores in short versions of cognitive

evaluation – like as MoCA – can be reliably predicted by more complex and articulated batteries of assessment, especially in adults with relevant cognitive impairment.

Vogel, Banks, Cummings and Miller (2015) examined individual MoCA domains by comparing them with more complete neuropsychological measures, applying both the instruments in patients with degenerative diseases. The results of this study showed that four of the subscores of the MoCA domains, i.e. visual spatial executive function, memory, attention and language are correlated with standard neuropsychological measures that measure similar cognitive constructs.

For this reason, and for practical uses in the diagnostic settings, it is possible to hypothesize that MoCA can be used as a "cognitive screening" that reflects in synthesis some constructs similar to those measured by a complete battery.

The results of a recent study (Sugarman & Axelrod, 2014) show how the two cognitive screening tests, MoCA and MMSE, can help predict general intellectual functioning in the elderly. The analyses of regression determined that MoCA and MMSE are both moderately correlated with the Full Scale WAIS-IV intelligence quotient. The forecast improves when these measures are combined with other IQ estimates.

However, in the literature there are still no data that show the correlation between the Italian versions of WAIS-IV and MoCA tests in subjects diagnosed with intellectual disability.

Reassuming the common problems of the neuropsychological assessment in clinical practice and research, Capitani (1997) suggested the concept of "Cognitive Mastery", measurable just by a definition a priori of a cut off, a numerical number, to define if the subject's results are within the standard for his or her age and education, or below the threshold. This approach, typical of neuropsychological tests and screening tools like as MMSE or MoCA, is different from that used in complex batteries (e.g., WAIS) based on several scores or profiles. Is it possible, and useful, to reassume more intellectual domains – e.g., WAIS factors – in a score that synthesize these domains to assess global intellectual deterioration?

It is useful, both for theoretical and applicative purposes, to identify what aspects of intelligence underlies WAIS-IV battery and MoCA and what relations can be detected among them, in adults diagnosed with intellectual disability.

2. Experimental study

2.1. Aims

The aims of the study were to assess the relations between WAIS-IV and MoCA, and to test the hypothesis that WAIS-IV factors, representing different cognitive subdomains, can differently predict the deterioration measured by MoCA in adults with Intellectual Disability.

2.2. Sample

The sample of the study was composed of 40 adults, 27 males and 13 females diagnosed with Mild or Moderate Intellectual Disability. The age range was 16-64 years, mean age 35.70 (*sd* 11.89). All the subjects were inpatients of a structure for the rehabilitation of persons with diagnosis of Intellectual Disability.

2.3. Instruments

1. The *Wechsler Adult Intelligence Scale – Fourth Edition* (*WAIS-IV;* Italian edition 2013) gives an overall assessment of the cognitive abilities of adolescents and adults aged between 16 and 90 years. It provides a total score of IQ, representative of general intellectual ability, and four composite scores, which measure specific cognitive domains: Verbal Comprehension Index (VCI), Visual Perceptual Reasoning Index (PRI), Working Memory Index (WMI) and Processing Speed Index (PSI). Each factor is represented by core and supplementary subtests:
   - Verbal Comprehension: Similarities, Vocabulary, Information (core subtests), Comprehension (supplementary).
   - Perceptual Reasoning: Block Design, Matrix Reasoning, Visual Puzzles (core); Picture Completion and Figure Weights (for ages 16-69 only).
   - Working Memory: Digit Span and Arithmetic (core); Letter-Number Sequencing (supplementary, ages 16-69 only).
   - Processing Speed Scale: Symbol Search and Coding (core); Cancellation (supplementary, ages 16-69 only).

   All the subtests were administered in our study; the composite scores and IQ derived from core subtest as indicated in the manual. While

standardization for age is provided, no correction for education is foreseen.

2. The *Montreal Cognitive Assessment (MoCA;* Italian version: Pirani, Tulipani & Neri, 2006; Santangelo, Siciliano, Pedone, Vitale, Falco, Bisogno *et al.*, 2015) consists of several tasks which explore the following cognitive domains:
   - Visual-spatial abilities, evaluated by drawing a clock (3 points), copying a cube (1 point); and executive functions, evaluated through a brief version of the task of the Trail Making test B (1 point - score range for this category: 0 - 5);
   - Denomination, assessed by naming animals with low-familiarity (3 points);
   - Memory, evaluated through a delayed recall (after 5 minutes) of five words, after two verbal repetitions (score 0-5);
   - Attention and concentration, assessed by means of a digit span task (1 point for each of the two series, forward and backward span tasks), plus a serial subtraction task (3 points), and a sustained attention task requiring the detection of a target (1 point);
   - Language, evaluated through the repetition of two syntactically complex sentences (2 points) and Verbal fluency (1 point);
   - Abstract reasoning of two elements (2 points);
   - Temporal and spatial orientation (score between 0 and 6), evaluated by structured questions (for example asking "Tell me the exact date, year, month and day of the week"; "Tell me the name of this place and in which city it is").

   The total MoCA score varies from 0 (worst performance) to 30 (best performance). This score should be corrected both for age and education (for the Italian version: Conti, Bonazzi, Laiacona, Masina, & Vanelli Coralli, 2015).

2.4. Data analysis

Basic statistics, comparison of means for gender (Student *t*), and zero-order correlation (Pearson coefficients) with Bonferroni correction for multiple comparisons, were computed firstly. A multiple regression analysis was used for assessing what WAIS-IV factors scores predict better the MoCA score. A Multidimensional Scaling was performed on the matrix of correlations among MoCA subdomains and WAIS-IV factors scores, using

Guttman loss function, minimizing Guttman/Lingoes coefficient of alienation in 2 dimensions. To perform the analyses the Systat software was used.

3. Results

Means and standard deviation for WAIS-IV factors and MoCA were preliminarily compared between males and females (Tab. 1). All the comparisons are not statistically significant.

Table 1 - *Means and standard deviation for WAIS-IV factors and MoCA total score. Analysis of gender differences*

	Males (n = 27)		*Females (n = 13)*			
	M	*sd*	*M*	*sd*	*t*	*p (df 38)*
Verbal Comprehension	55.44	5.09	54.54	5.72	.51	.62[a]
Perceptual Reasoning	52.70	8.11	52.08	7.70	.23	.82[a]
Working Memory	51.52	3.26	51.00	2.65	.50	.61[a]
Processing Speed Scale	52.19	4.92	52.62	6.96	-.23	.82[a]
MoCA (Total)	11.70	4.71	9.31	4.19	1.56	.13[b]

[a] after Bonferroni correction $p = 1.00$; [b] for MoCA $p = .64$

Table 2 shows that both the total IQ and the WAIS-IV factors are significantly ($p < .05$) correlated with MOCA score, except the Processing Speed ($r = .25$, $p > .05$). Among the single WAIS-IV subscores only Puzzle and Cancellation show small correlations with MOCA score ($r < .30$, $p > .05$).

The multiple regression, using as predictors the WAIS-IV factors and the MoCA total score as dependent variable, confirm the Verbal Comprehension as the best predictor ($\beta = .52$, $p < .001$), followed by Working Memory ($\beta = .21$). The other two factors are not relevant in predicting the deterioration measured by MoCA (Tab. 3).

Table 2 - *Zero-order correlations between WAIS-IV total IQ, factors, and subscores, vs MoCA (Pearson coefficient)*

WAIS-IV subscores and factors	MoCA	WAIS-IV subscores and factors	MoCA
Total IQ	.64***	Information	.49***
Verbal Comprehension	.68***	Coding	.42**
Working Memory	.55***	Letter Number Sequencing	.62***
Perceptual Reasoning	.51***	Figure Weights	.50***
Processing Speed	.25	Comprehension	.52***
Block Design	.62***	Cancellation	.21
		Picture Completion	.37*
Similarities	.71***	Digit Span Forward	.54***
Digit Span	.75***	Digit Span Backward	.75***
Matrix Reasoning	.51***	Digit Span Sequencing	.66***
Vocabulary	.55***	Span Forward	.59***
Arithmetic	.59***	Span Backward	.64***
Symbol Search	.36**	Span Sequencing	.55***
Visual Puzzles	.25	Span Letter - Number Sequencing	.41**

*** $p < .001$; ** $p < .01$; *$p < .05$ (after Bonferroni correction)

Table 3 - *Multiple regression. Dependent variable: MoCA; predictors: WAIS-IV factor scores. R^2 of the model .51*

Effect	Std. Coeff.	*t*	*p*-value
Verbal Comprehension	.52	3.24	< .001
Working Memory	.21	1.34	.19
Perceptual Reasoning	.05	.33	.75
Processing Speed	.03	.26	.80

Table 4 – *Zero-order correlations between WAIS-IV factors and subscores of MoCA (Pearson coefficient)*

	Vis-spat.	Denom.	Attent.	Lang.	Abstr.	Memory	Orient.
Total IQ	.57***	.47***	.33*	.60***	.24	.21	.38**
Verbal Comprehension	.55***	.51***	.45**	.61***	.31	.11	.41**
Working Memory	.33*	.28	.57***	.49***	.21	.10	.34
Perceptual Reasoning	.53***	.41**	.16	.52***	.28	.20	.25
Processing Speed	.22	.23	.02	.18	-.16	.20	.24

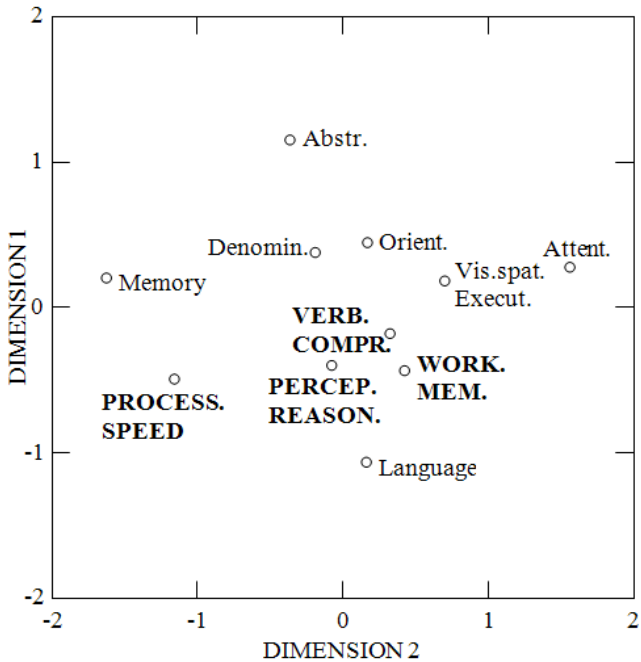
*** $p < .001$; ** $p < .01$; *$p < .05$ (after Bonferroni correction)

Table 4 shows the correlations among the WAIS-IV factors and the separated domains composing MoCA total score (scores have been aggregated by function, avoiding item assigning only 1 point). The most significant correlations are between:

- Both Visual-spatial and executive functions and Denomination (MoCA) with Verbal Comprehension and Perceptual reasoning (WAIS-IV);
- Attention (MoCA) with Working Memory (less with Verbal Comprehension);
- Language (MoCA) with all the WAIS-IV factors;
- Orientation (MoCA) mainly with Verbal Comprehension;
- The global IQ with all the MoCA subscores (more significantly with Visual-spatial and executive functions and Linguistic domains), while correlations with Abstraction and Memory are moderate and non significant.

Overall, the abstract functions and memory as measured by MoCA subscores are not significantly correlated with any WAIS-IV factor in our sample of adults with Intellectual Disability.

Figure 1 - *Multidimensional Scaling of MoCA subdomains and WAIS-IV factor scores (in bold). Stress of final configuration = .18; Proportion of Variance (RSQ) = .87*



The Multidimensional Scaling analysis (Fig. 1) evidences a first dimension contrasting Abstraction vs Language (as assessed by MoCA), the latter being close to all the WAIS-IV factors. A second dimension has MoCA Attention and Memory at the two polarities.

The WAIS-IV factors (mainly Verbal Comprehension) are placed in a central position on both the two dimensions, being Working memory more close to MoCA Visual-spatial and Attentive polarity, while Processing speed is more close to Memory as measured by MoCA, which appears to be different from the Working memory assessed by the WAIS-IV.

4. Discussion and conclusions

The results of our study permit to conclude that the WAIS-IV full IQ and the total MoCA score are significantly correlated (.64). Considering the four factorial IQ, the MoCA total score is best predicted by Verbal Comprehension, less by Working Memory.

The relations between WAIS-IV factors and MoCA subscores confirm the relevance of the factor Verbal Comprehension for almost all the MoCA subdomains, except Abstraction and Memory, not correlated with any of the WAIS-IV factors. Correspondingly, the linguistic component measured by MoCA is close to all the WAIS-IV factors.

The memory functions assessed by MoCA appear to be different from those of WAIS-IV Working Memory, factor more close to the MoCA visuo-spatial subdomain.

The overlapping, relevant but only partial, of the functions measured by the two instrument leads to a general conclusion about the practical use in diagnostic settings.

While a screening of the global level of deterioration can be reliably made by means of a test like MoCA, the analysis of how every single domain influences the general intelligence (and/or its impairment) can be made more accurately with a battery (e.g., WAIS-IV o similar) suitable for defining a complete profile of the different factors composing the intelligence.

This is important not only for a better definition of intellectual deterioration, but for highlighting the potential rehabilitation too. If intellectual disability identifies a general condition of cognitive impairment, then knowing which cognitive domains take a main role in this impairment could expand rehabilitation prospective of the specific impaired cognitive

functions, with the aim of improving cognitive performance in adults diagnosed with intellectual disabilities.

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