Norms for Letter and Number Sequencing, Figure Weights and Cancellation subtests for the elderly Italian population

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ABSTRACT. La somministrazione dei tre subtest supplementari *Riordinamento di lettere e numeri*, *Confronto di pesi* e *Cancellazione* della WAIS-IV a soggetti con età superiore ai 69 anni non è prevista in alcuna taratura degli altri Paesi del mondo. Poiché non siamo riusciti a trovare una giustificazione di tale decisione, in fase di taratura della WAIS-IV i curatori hanno deciso di somministrare tutti e 15 i subtest anche ai soggetti dai 70 ai 90 anni di età. In questo lavoro si presenta la tabella di conversione dei punteggi grezzi in punti ponderati per quattro fasce di età tra i 70 e i 90 anni. Inoltre, si forniscono le attendibilità e gli errori standard di misura dei tre subtest per le quattro fasce di età. Si discute sull'utilità per il clinico dell'utilizzo di tali subtest con gli anziani.

SUMMARY. The administration of the three supplementary subtests Letter and Number Sequencing, Figure Weights and Cancellation in WAIS-IV to people over 69 years of age is not included in the scaling of any other countries around the world. Since it was not possible to find a justification for this decision, the curators decided to administer all 15 subtests to people aged 70 to 90 during WAIS-IV scaling. This work presents the table converting raw scores into weighted points for four age groups between the ages of 70 and 90. It also provides the reliability and the standard measurement errors of the three subtests for the four age groups. The usefulness to clinicians of using these subtests among the elderly is discussed.

Keywords: *WAIS-IV, Ageing, Letter and Number Sequencing, Figure Weights, Cancellation*

INTRODUCTION

The fourth edition of the *Wechsler Adult Intelligence Scale* (*WAIS-IV,* Wechsler, 2008a, 2008b) is a clinical tool that can be administered to individuals to measure the intelligence of adolescents and adults aged between 16 years, 0 months and 0 days and 89 Years, 11 months and 30 days. The structure of WAIS-IV involves composite scores in specific cognitive areas such as the Verbal Comprehension Index (VCI), the Perceptual Reasoning Index (PRI), the Working Memory Index (WMI), and the Processing Speed Index (PSI). Each of these indices contributes to the composite score represented by total IQ, alternatively defined as the expression of general intelligence ability.

The 15 subtests belonging to each of the indices are subdivided into 10 labelled fundamental and 5 supplementary. To obtain the 4 indices and the total IQ it is sufficient to administer the 10 fundamental subtests, while the 5 additional subtests can be administered in two circumstances. The first circumstance is when the clinician needs to substitute a fundamental subtest with one of the supplementary ones (e.g. if a person has physical or sensory limitations, or if the scores from a fundamental subtest are invalidated due to administration errors or because the person always answers "don't know"); the second is when there is seen to be the need for a clinical investigation of a particular cognitive ability, completing the diagnosis by analysing discrepancies between several subtests.

The Verbal Comprehension Index includes three fundamental subtests (*Similarities*, *Vocabulary* and *Information*) and a supplementary subtest (*Comprehension*). The Perceptual Reasoning Index contains three fundamental subtests (*Block Design*, *Matrix Reasoning* and *Visual Puzzles*) and two supplementary subtests (*Figure Weights* and *Picture Completion*). The Working Memory Index includes two fundamental subtests (*Digit Span* and *Arithmetic*) and one supplementary subtest (*Letter* and *Number Sequencing*). Finally, the Processing Speed Index includes two fundamental subtests (*Symbol Search* and *Coding*) and one supplementary subtest (*Cancellation*).

Letter and Number Sequencing, Figure Weights and *Cancellation* are three supplementary subtests to be used only with people between the ages of 16 and 69, and therefore not with people aged 70 or over. The decision to not administer these subtests to these older age groups was not discussed or explained in the *Technical and Interpretive Manual* of WAIS-IV (Wechsler, 2008b), or in the literature regarding the Wechsler scale.

Letter and Number Sequencing (a supplementary subtest in the Working Memory Index) can be a valid substitute for the *Digit Span* subtest or the *Arithmetic* subtest for situations in which the performance of one of these two subtests is invalidated. In this subtest a sequence of mixed numbers and letters is read to the subject, who is asked to repeat the numbers in ascending order and the letters in alphabetical order. The task requires attention, concentration, mental manipulation, sequential processing, and short-term auditory memory capacity. It may also call for the processing of information, cognitive flexibility and fluid intelligence (Crowe, 2000; Groth-Marnat, 2003; Kaufman & Lichtenberger, 1999, 2006; Sattler, 2008). This subtest also includes a processing score which consists of the memory span of letters and numbers, i.e. the number of elements that make up the last correctly recalled sequence. This score can be particularly informative in cases in which performance is variable, for example if a person makes a mistake in one or two tests in various sequences.

Figure Weights is a supplementary subtest in the Perceptual Reasoning Index in which the person being tested observes some scales in equilibrium, one of which has a missing weight on a pan, and must select (within a time limit) the option that keeps the scales in equilibrium. This subtest was designed to measure a specific aspect of fluid reasoning: non-verbal and analogical quantitative reasoning. According to Carroll (1993), quantitative reasoning tasks involve reasoning processes that can be expressed mathematically through the use of inductive or deductive logic. Although the subtest also requires memory work to some extent, its weight is lower than that of classical quantitative reasoning tasks (such as in the *Arithmetic* subtest); this is because the *Figure Weights* subtest takes place through a visual presentation of the stimuli (the scales and weights), which enables the person to keep them constantly in view - and thus alive in his or her short-term memory - while seeking the solution to the problem. To find the correct solution to the various subtest tasks, however, the working memory is involved more as the difficulty of the items increases: the more difficult items require the consideration of a higher number of quantitative relationships between the shape and weight of the stimuli. This relationship between reasoning and working memory is unsurprising given the results of studies that suggest a

dynamic interaction between fluid reasoning, working memory and processing speed (Kyllonen & Christal, 1990; de Ribaupierre & Lecerf, 2006; Salthouse & Pink, 2008; Unsworth & Engle, 2007).

The *Cancellation* subtest is an additional subtest in the Processing Speed Index in which the people being tested analyse a structured system of figures and, within a predetermined time limit, have to mark the target figures. This subtest can function as a good substitute for the *Coding* subtest in situations in which the person being tested has low fine motor skills, or as a substitute for one of the two fundamental subtests within the Index (*Coding* or *Symbol Search*) in the event that one of these is invalidated. The *Cancellation* subtest was designed to measure processing and perception speed, selective visual attention, and vigilance and visual-motor skills (Bate, Mathias & Crawford, 2001; Geldmacher, Fritsch & Riedel, 2000; Sattler, 2008; Wojciulik, Husain, Clarke & Driver, 2001).

Cancellation tasks are mainly used in neuropsychological contexts such as the measurement of visual neglect and inhibition of motor response and perseverance (Adair, Na, Schwartz & Heilman, 1998; Geldmacher et al., 2000; Lezak et al., 2004; Na et al., 1999). Some studies have highlighted an age-related reduction in performance in the processing of visual information that is not associated with the presence of illness. These changes have been described as declines in visual research, in the identification processes of target stimuli and in the rapidity of attention shifts (Folk & Hoyer, 1992; Plude & Doussard-Roosevelt, 1989). According to Geldmacher et al. (2000) "Examining the effects of age on cancellation tasks is important, since these are normally used for the clinical evaluation of the visuospatial function in age-related illnesses such as stroke and dementia" (p.196).

These three subtests (*Letter and Number Sequencing*, *Figure Weights* and *Cancellation*) were administered to all subjects in the Italian WAIS-IV scaling sample, including those aged 70 to 90 years. The objective of a recent international article by Pezzuti & Rossetti (2017) was to study the factorial invariance and mean differences in factors of the hierarchical model (4 first-order factors corresponding to the 4 Indices and a second-order factor corresponding to general intellectual ability) of WAIS-IV among Italian adults and elderly people belonging to the standardisation sample. The results confirmed the configural and structural invariance of WAIS-IV between the two age groups, showing that the second-order hierarchy model is equally valid among the elderly population even when all 15 WAIS-IV subtests are considered. In the conclusions of the above-mentioned article a forthcoming Italian publication was announced that would enable Italian clinicians to use a table to convert the raw scores from the three subtests *Letter and Number Sequencing*, *Figure Weights* and *Cancellation* for 4 age groups within the 70 to 90 age range.

The objective of this work, therefore, is to provide this table as well as a table with the distribution of the cumulative frequencies of the *Letter and Number Sequencing Spans* (LNS) for the four age groups. It also provides the reliability and the standard measurement errors of the three subtests for the four age groups.

METHODOLOGY

Sample and instrument

The sample of reference for this article is the Italian WAIS-IV scaling sample consisting of 750 subjects aged 70 to 90, sub-divided into 4 age groups: 200 subjects (100 males and 100 females) aged 70 to 74; 200 (100 males and 100 females) aged 75 to 79; 200 subjects (100 males and 100 females) aged 80 to 84; and 150 subjects (75 males and 75 females) aged 85 to 90 (Orsini & Pezzuti, 2015). To make the four age groups representative of the Italian population in terms of educational level, each contains a number of subjects proportionate to the percentage of people in the Italian population possessing one of the following four educational levels: a) up to primary school certificate; b) middle school certificate; c) high school diploma; d) degree. This representative design was drawn up using data from the 15th ISTAT National Census (ISTAT, 2011).

Data analysis

To obtain the tables for converting raw scores into weighted scores, for each of the four age groups the raw scores of the 3 supplementary subtests *Letter and Number Sequencing*, *Figure Weights* and *Cancellation* were converted into weighted scores with $M = 10$ and $SD = 3$, using the continuous norming method proposed by Gorsuch (Gorsuch, 1983; Zachary & Gorsuch, 1985). A method that requires the

use of specific procedures to take into account the effect of age on both the means and the standard deviations of the raw score distributions. The weighted scores of the subtests vary between 1 and 19.

This procedure was not used for the *Letter and Number Sequencing Span*, for which the frequency distribution of the raw scores for each of the four age groups is reported.

As regards the study on the reliability of the subtests, with the exception of *Cancellation* - for which the test-retest method was used - the reliability of *Letter and Number Sequencing* and *Figure Weights* was calculated using the split-half method, correcting for the length of the test with the Spearman-Brown prophecy formula.

RESULTS

Table 1 shows the data for converting the raw scores of the three supplementary subtests into weighted scores according to the age of the subject. For example, if a 75-year-old person has obtained a raw score of 26 in the *Cancellation* supplementary subtest, this corresponds to a weighted score of 11.

Table 2, on the other hand, shows the cumulative frequencies of the *Letter and Number Sequencing Span*. For example a Span of 6 in the *Letter and Number Sequencing* subtest is obtained by 6% of the population aged 70 to 74.

Finally, Table 3 shows the results for reliability and standard measurement error (*SME*) of the three subtests by the 4 age groups. As can be observed, the reliability of the three subtests ranges from .86 for the *Cancellation* subtest among the 75-79 age group, and .92 for the *Letter and Number Sequencing* subtest among the 85 to 90 age group. These indices, according to Nunnally & Bernstein (1994), are from very good to excellent.

CONCLUSION AND DISCUSSION

The administration of the three supplementary subtests *Letter and Number Sequencing*, *Figure Weights* and *Cancellation* in WAIS-IV to people aged 70 to 90 is not included in the scaling of any other countries in the world, the instruction for this age group being to administer 12 subtests out of 15. Since it was not possible to find a scientific justification for this decision, the curators decided to administer all 15 subtests to people aged 70 to 90 during the Italian WAIS-IV scaling. However, when the Italian scaling was published no information was given regarding those three supplementary subtests administered to the elderly. Pezzuti & Rossetti (2017) subsequently set out to study whether, when using all 15 subtests, the hierarchical structure with 4 first-order factors (verbal comprehension, perceptual reasoning, working memory and processing speed) and a second-order factor (general intellectual ability) remained the same also for the elderly. Having obtained confirmation of this, this work provides the norms for using these subtests also with this age group.

Having the norms of these three subtests also for the elderly can increase the usefulness of WAIS-IV in evaluating the cognitive abilities of this population, improving its potential for use clinically and in research. We agree with Wechsler (2008a) when he says that each of the three subtests can provide additional information on intellectual functioning for clinical interpretation and decision-making, but it should be added that this would also seem to be true not only for adults but also for the elderly. Additionally, having these supplementary subtests also for people aged 70 to 90 provides clinicians with the possibility of using them as substitutes if needed (for example in the event of an invalid score in one of the fundamental subtests, or when a subject presents particular characteristics or limitations). It can be reasonably concluded that possessing the norms for all 15 subtests also for older age groups will give an opportunity to reflect more thoroughly on the typical performance of the elderly and on their strengths and weaknesses in intellectual abilities.

Table 1 – Conversion of raw scores into weighted scores for 4 age groups

	70-74 years			75-79 years			80-84 years			85-90 years			
PP	**LN**	**FW**	**CA**	**FW**	**CP**	**CA**	**LN**	**FW**	**CA**	**LN**	**FW**	**CA**	**PP**
19	27-30	18-27	58-72	25-30	17-27	51-72	24-30	15-27	45-72	22-30	13-27	39-72	**19**
18	26	17	54-57	24	16	48-50	22-23	14	42-44	21	–	36-38	**18**
17	24-25	16	51-53	23	15	45-47	21	13	40-41	19-20	12	34-35	**17**
16	23	15	47-50	21-22	14	42-44	19-20	12	37-39	18	11	31-33	**16**
15	21-22	14	44-46	20	13	39-41	18	11	34-36	16-17	10	29-30	**15**
14	20	13	40-43	18-19	12	36-38	17	–	31-33	15	9	26-28	**14**
13	18-19	12	37-39	17	11	32-35	15-16	10	28-30	13-14	–	24-25	**13**
12	17	11	33-36	15-16	10	29-31	14	9	25-27	12	8	21-23	**12**
11	15-16	10	30-32	14	9	26-28	12-13	8	22-24	11	7	19-20	**11**
10	14	8-9	26-29	12-13	8	23-25	11	7	20-21	9-10	6	16-18	**10**
9	12-13	7	23-25	11	7	20-22	9-10	6	17-19	8	5	14-15	**9**
8	11	6	19-22	9-10	6	17-19	8	5	14-16	6-7	4	11-13	**8**
7	9-10	5	16-18	8	5	13-16	6-7	4	11-13	5	–	9-10	**7**
6	8	4	12-15	6-7	4	10-12	5	3	8-10	3-4	3	6-8	**6**
5	6-7	3	9-11	5	3	7-9	3-4	2	5-7	2	2	4-5	**5**
4	5	2	5-8	3-4	2	4-6	2	0-1	2-4	0-1	0-1	0-3	**4**
3	4	0-1	2-4	2	0-1	0-3	0-1	–	0-1	–	–	–	**3**
2	2-3	–	0-1	0-1	–	–	–	–	–	–	–	–	**2**
1	0-1	–	–	–	–	–	–	–	–	–	–	–	**1**

Legenda. LN = Letter and Number Sequencing; FW = Figure Weights; CA = Cancellation.

Table 2 – Cumulative percentages, averages, standard and median deviations of the Letter and Number Sequencing Span by age group

Span L-N	70-74	75-79	80-84	85-90	Span L-N
8	.0	.0	.0	.0	**8**
7	.0	.0	.0	.0	**7**
6	6.0	.7	.5	.5	**6**
5	26.5	4.0	9.5	5.5	**5**
4	60.5	14.0	41.5	25.5	**4**
3	92.5	76.7	88.0	85.0	**3**
2	99.5	98.7	99.0	100.0	**2**
1	100.0	99.4	99.5	100.0	**1**
0	100.0	100.0	100.0	100.0	**0**
Average	3.85	2.93	3.38	3.16	**Average**
SD	1.04	.77	.87	.76	***SD***
Median	4	3	3	3	**Median**

Table 3 – Reliability and standard measurement errors of the three subtests by age group

		LN	FW	CA
r_{el}	70-74	.90	.90	.89
	75-79	.90	.88	.86
	80-84	.90	.87	.89
	85-90	.92	.87	.88
SME	70-74	1.44	1.04	3.56
	75-79	1.36	1.06	3.35
	80-84	1.32	.94	3.10
	85-90	1.30	.92	2.53

Legenda. LN = Letter and Number Sequencing; FW = Figure Weights; CA = Cancellation; r_{el} = Reliability; SME = Standard Measurement Error.

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