Normative data and validation of the Italian translation of the Working Memory Questionnaire (WMQ)

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ABSTRACT

Reliable and valid measures are necessary to assess subjective working memory complaints that can be distinct from objective memory performance. The Working Memory Questionnaire (WMQ) is a self-administered scale proposed by Vallat-Azouvi. It assesses the three different working memory domains (memory storage, attention, and executive functions) in accordance with Baddeley's working memory model. Our aim was to propose an Italian translation of the WMQ and provide normative data. We collected normative data from 697 healthy Italian participants aged between 18 and 88 years. Percentiles and cutoff scores, taking into consideration age, gender, and education, were provided for the WMQ total scores and the three separate domains. The performance on the WMQ was influenced by age and education. In particular, age and education affected self-perceived working memory efficacy. Our data demonstrate a significant correlation between the WMQ and paper-and-pencil tests assessing working memory, attention, and executive functions. This study provides normative data that have been adjusted for relevant demographics and percentile grids in an Italian population. The results are in line with a previous French study that also supported the use of the WMQ as a valid prescreening instrument for working memory deficits in clinical practice.

KEYWORDS

Attentive disorders; ecological assessment; executive functions; Italian standardization; working memory deficits

Introduction

The working memory system is responsible for temporarily holding information available for processing and manipulation (Miyake & Shah, 1999). By the end of the 1970s, Baddeley and Hitch (1974) proposed the working memory multicomponent model, in which they subdivided working memory into three components: the central executive, the phonological loop, and the visuo-spatial sketchpad. Specifically, the central executive has the aim to direct the attention toward relevant information, coordinating cognitive processes when one or more than one task is simultaneously performed and supervising the other two components. It also updates and binds information, shifts between tasks and strategies, and suppresses dominant or automatic responses (Wongupparaj, Kumari, & Morris, 2015). The phonological loop stores phonological information and prevents its decay by continuously refreshing it in a rehearsal loop. The visuo-spatial sketchpad stores visual and spatial information. Subsequently, Baddeley (2000) also added a fourth component: the episodic buffer, which holds representations that integrate phonological, visual, and spatial information and binds information into a unitary episodic representation.

When older people complain of memory problems, they refer to deficits in maintaining information online for a short period, such that they forget the content of a recent recall, or which object they are looking for when coming into a room. This kind of difficulty may be attributed to a working memory deficit. In particular, some suffer from Subjective Memory Complaints (SMC), even if their performance on memory tasks falls within the normal range (Vannini, Hanseeuw, Munro, et al., 2017). The prevalence of SMC in older people is estimated to be 22–56% (Jorm et al., 1994; Geerlings, Jonker, Bouter, Ader, & Schmand, 1999; Montejo, Montenegro, Fernandez, & Maestu, 2011).
Advanced age and low education level are frequently associated with SMC (Montejo et al., 2011). A series of studies (e.g., Bolla, Lindgren, Bonaccorsy, & Bleecker, 1991; Cutler, & Grams, 1988) have taken into consideration the following variables for predicting memory complaints: age, emotional stress, depression, and perceived health status.

SMC are considered one of the criteria for the diagnosis of Mild Cognitive Impairment (MCI; Albert et al., 2011). Self-perceived memory disorders could be one of the earliest signs of Alzheimer’s disease (AD); for this reason, it is important not to underestimate these complaints. Memory changes may reflect the temporal duration (working memory and long-term memory) and storage capacity. (Baddeley, Bres, Della Sala, Logie, and Spinnler, 1991; Logie, Cocchini, Della Sala, & Baddeley, 2004) found that patients with AD are impaired when performing multiple tasks simultaneously, regardless of the difficulty of the tasks. Logie et al. (2004) demonstrated that a specific deficit in the central executive characterized the working memory problems described in patients with AD.

However, working memory deficits are present not only in old people or in cognitive decline but also in several pathologies, including Traumatic Brain Injury (TBI). TBI is an acquired neurological disorder with high incidence worldwide; it involves cognitive impairments that impact the quality of life of both patients and their families/caregivers (Lin et al., 2010). TBI patients have shown the main difficulties in executive functions (EF), that is, being unable to plan, solve problems, monitor, inhibit, and update information (Miyake et al., 2000). Some of these difficulties, specifically working memory deficits, may also be present in mild TBI and may be underestimated and not assessed at first sight.

To identify deficits that could subsequently result in everyday difficulties and considering individuals with SMC who do not fail in traditional neuropsychological tests, it would be useful to have self-reported standardized instruments that provide evidence of working memory deficits that distinguishes among memory storage, attention, and executive function deficits. Vallat-Azouvi, Pradat-Diehl, and Azouvi (2012) developed and provided normative data for the Working Memory Questionnaire (WMQ), a self-administered scale, addressing the three dimensions of working memory: short-term memory storage, attention, and executive control. They found that the WMQ has good validity and can discriminate patients with brain injury from healthy controls. Furthermore, it seems to reflect specifically on the consequences of the dysfunction of the central executive of working memory in everyday life. The development of the WMQ is noteworthy because a limitation for the neuropsychological testing of memory and executive functions is that patients’ performance on these tests may have minimal predictive value for how they may perform in a real-world situation (e.g., Chaytor, Schmitter-Edgecombe, & Burr, 2006). Several studies have demonstrated that performance on traditional tests has little correspondence to activities of everyday life; specifically, clinicians have doubts about the efficacy of these tests in predicting the way in which patients will manage activities of daily living (e.g., Bottari, Dassa, Rainville, & Dutil, 2009; Manchester, Priestley, & Howard, 2004; Sbordone, 2008). In recent years, the need of an assessment that represents real-world functioning and has ecological validity has led to the development of an increasing number of ecologically relevant tests (Chaytor & Schmitter-Edgecombe, 2003; Piccardi, Magnotti, Tanzilli, Aloisi, & Guariglia, 2016). Generally, ecological validity refers to the degree to which test performance corresponds to real-world performance (Tupper & Cicerone, 1990).

Validity does not apply to the test itself but to the inferences that are drawn from the test (e.g., Franzen & Arnett, 1997; Heinrichs, 1990); for this reason, a questionnaire such as the WMQ allows neuropsychological testing in a more focused manner.

In the present study, we translated the WMQ into Italian and also provide normative data; introducing this instrument into neuropsychological prescreening will allow the categorizing of working memory complaints in several clinical populations. Furthermore, we have also investigated the concurrent validity of the Italian WMQ, and we analyzed the performance of a small group of individuals who failed in the Mini Mental State Exam (MMSE) with respect to their self-reported WM scores.

Methods

Subjects

The normative sample was composed of 725 healthy participants (age range =18–88; M = 40.4 ± 17.4; 429 women and 296 men). Participants were grouped into five age cohorts defined by age at last birthday.

Subjects were recruited from the communities of three Italian regions (Abruzzo, Lazio, and Sicily) by word of mouth and flyers that were distributed throughout the university areas (i.e., bookshops, cafeterias, and public library) and community meeting
points (primarily the library, sports clubs, activity centers for elderly people, and churches). After contacting the experimenter, participants received an information sheet that explained the procedures and goals of the study and the exclusion criteria. If they were eligible and were still willing to participate, they were invited to visit the university laboratory.

The inclusion criteria were the following: age of 18 years and over, absence of any cognitive or functional impairment as self-reported by participants during an informal interview before taking part in the test phase, Italian as the native language, and normal or corrected non-normal vision and hearing. The exclusion criteria were the following: any neurological or major psychiatric illness, the use of psychotropic medications, previous traumatic brain injury, history of learning disabilities, alcohol or drug abuse, subjective complaints of cognitive impairment and any major medical illness. The absence of these conditions was confirmed during an informal interview carried out before the test phase. To identify the presence of mental deterioration in participants over 40 years old, they were administered the MMSE (Folstein, Folstein, & McHugh, 1975; Italian version: Frisoni, Rozzini, Bianchetti, & Trabucchi, 1993; cutoff = 23: Magni, Binetti, Bianchetti, Rozzini, & Trabucchi, 1996).

Of the initial sample, 28 participants were excluded because they did not meet the inclusion criteria. The final sample comprised 697 healthy participants (280 men and 417 women) aged between 18 and 88 years (mean = 39.30 years, SD = 16.62 years). Their level of full-time education ranged between 3 and 23 years (mean = 12.69 years, SD = 3.50 years). Each age group was subdivided in two subgroups based on education (Low: 5–12 years and High: 13–18 years; both educational subgroups included medium educational levels) and based on gender (M: men; F: women). Regarding the demographics (i.e., gender and educational level), the sample aligned well with Italian census results (15th Population and Housing Census, 2011) (see Table 1 for demographics).

All subjects volunteered to participate and provided their informed consent. The study was designed in accordance with the ethical principles of human experimentation stated in the Declaration of Helsinki and was approved by the Institutional Review Board of the Department of Life, Health and Environmental Science, University of L’Aquila.

### Instruments

Participants were tested individually in a well-lit and quiet room. The following instruments were administered:

- The Working Memory Questionnaire (WMQ: Vallat-Azouvi et al., 2012) has been translated in Italian (see Supplemental Material for Italian Version of the WMQ) and back translated by a native speaker to be certain that the Italian version was comparable to the original version. The WMQ is a self-report questionnaire that consists of 30 items investigating the three different domains of working memory (10 items for each domain): short-term memory storage, attention, and executive function. The first domain assesses the ability to maintain information in short-term memory for a short period of time (e.g., “Do you find it difficult to remember the name of a person who has just been introduced to you?”). Attention includes items on distractibility, mental slowness, mental fatigue, or dual-task processing (e.g., “Do you feel that you tire quickly during the day?”). The executive aspects of working memory concern decision making, planning ahead, or shifting (e.g., “Do you find it difficult to carry out a project such as

| Age range | 18–28 years (N = 249) | 29–39 years (N = 137) | 40–50 years (N = 109) | 51–60 years (N = 113) | 61–88 years (N = 89) |
|-----------|----------------------|----------------------|----------------------|----------------------|----------------------|
| N         | 249                  | 137                  | 109                  | 113                  | 89                   |
| Age       | 22.36                | 33.77                | 45.06                | 54.68                | 68.66                |
| SD        | 3.05                 | 3.13                 | 3.31                 | 2.60                 | 6.70                 |
| Gender    |                      |                      |                      |                      |                      |
| Women     | 151                  | 74                   | 73                   | 67                   | 52                   |
| Men       | 98                   | 63                   | 36                   | 46                   | 37                   |
| Education |                      |                      |                      |                      |                      |
| M         | 13.61                | 13.39                | 12.58                | 11.86                | 10.26                |
| SD        | 2.56                 | 3.71                 | 3.67                 | 3.14                 | 4.25                 |
| Low       | 34                   | 32                   | 32                   | 45                   | 47                   |
| High      | 215                  | 105                  | 77                   | 68                   | 42                   |
| Age Midpoint | 23               | 34                   | 45                   | 55.5                 | 74.5                 |

Note. Education: sum of completed years of school.
choosing and organising your holidays?”). Participants completed the WMQ by rating their answers on five-point Likert scale, ranging from 0 (“no problem at all”) to 4 (“very severe problem in everyday life”). The maximum total score is 120 and the maximum subtotal score for each domain was 40. Higher scores corresponded to more self-identified difficulties.

- Concurrent validity on the total score was assessed through a scale that assesses cognitive or attention failures in daily living, the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), and through a general abstract reasoning measure, Raven’s Colored Progressive Matrices (Raven, 1986). Concurrent validity of the short-term memory storage domain was assessed through two verbal and visuo-spatial working memory tests (i.e., a forward and backward Digit Span task: Wechsler, 1981; Orsini et al., 1987; Orsini, 2003; and the Corsi Block-Tapping test, forward and backward: Corsi, 1972; Piccardi, Bianchini, Argento, et al., 2013). Concurrent validity of attention was assessed through a visual search test (Spinnler & Tognoni, 1987). Concurrent validity of executive functions was assessed through phonetic and semantic fluency (word fluency: Novelli et al., 1986; Capitani, Laiacona, & Barbarotto, 1999) and the rule shift cards a subtest of BADS (Behavioural Assessment of the Dysexecutive Syndrome; Wilson, 1996; Italian version: Antonucci, Spitoni, Orsini, D’Olimpio, & Cantagallo, 2014).

- Visual search test (Spinnler & Tognoni, 1987). A time-constrained selective attention test of visual searching. The subject’s task was to cross out target/digits from three different matrices (1, 2 and 3 targets respectively). The first two rows of each matrix were used for practice. Each subject’s score ranged from 0 (no targets crossed out) to 60 (all targets crossed out).

- Word fluency (Novelli et al., 1986; Capitani et al., 1999). This is a categorically and phonologically cued test of access to the lexicon. The subject was asked to generate as many words as possible from one category (animals) and of words starting from three different letters (P, F, and L) allowing 1 min for each trial. The subject’s score was the total number of words produced for both the categorical and phonological tasks.

- Corsi Block-Tapping test (CBT; Corsi, 1972; Monaco, Costa, Caltagirone, & Carlesimo, 2013; Piccardi et al., 2013). This test consists of 9 wooden blocks fixed on a board in a scattered array. The examiner taps a sequence of blocks and the participants had to reproduce the same sequence in (a) the same order in the fCBT (forward CBT) and (b) the reverse order in the bCBT (backward CBT). Sequences of increasing length (i.e., from a 2-block to a 9-block sequence) were presented until the participants failed to reproduce 1 out of 2 trials of a given length.

- Digit Span (DS), a subtest of the Wechsler Intelligence scale (Wechsler, 1981; Orsini et al., 1987; Orsini, 2003). The participants had to recall the same sequence in (a) the same order in the fDS (forward Digit Span) and (b) the reverse order in the bDS (backward Digit Span). The number of correct items was recorded as a digit score and the digit span was calculated as the longest sequence of digits recalled correctly.

- Raven’s Colored Progressive Matrices (CPM: Raven, 1938; Basso, Capitani, & Laiacona, 1987). The CPM assesses nonverbal abilities at three levels by measuring clear-thinking ability. The test consisted of 36 items in three series (A, AB, B) each including 12 trials of increasing complexity with an administration time of 10 min per individual. In each trial, a target picture was presented with a missing piece and six possible alternatives, one of which completes the target picture. Subjects were instructed to find among the alternatives the one that, inserted in the model, will form a logical whole. The score corresponded to the number of correct responses.

- Rule shift cards (a subtest of BADS: Antonucci et al., 2014). These measure the ability to change an established pattern of response using familiar materials. In part 1, a response pattern was defined according to a simple rule (subjects were instructed to answer “Yes” to a red card and “No” to a black card). In part 2, the rule was changed (subjects were instructed to respond “Yes” if the card that has just been turned over was the same color as the previously turned card and “No” if the color was different), and subjects had to adapt their responses and inhibit their original response set.

- Cognitive Failures Questionnaire (CFQ: Broadbent et al., 1982; Italian version Salmaso & Viola, 1989; De Beni et al., 2007). This is a self-reported 25-item scale aimed at assessing the frequency of failures in perception, memory and motor function in daily life during the past six months on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Stratta and co-workers (2006) had
performed a validation study of the Italian version of the CFQ, and with the aim to estimate the reliability of the questionnaire, they obtained Cronbach’s alpha score equal to 0.91, which means good reliability, and they did not individuate any item to exclude from the scale. Furthermore, their results with a factor analysis are comparable to those of other studies (Wagle et al., 1999; Matthews et al., 1990; Pollina et al., 1992; Wallace et al., 2002).

**Data analysis**

Statistical analyses were performed using SPSS Statistics 20.0. In the first step, multivariate analysis of variance (MANOVA) was performed to study the effects of gender, age and education on variables in the three domains of the WMQ. To interpret the effect size, we used eta squared values ($\eta^2$) ($\eta^2 > .01 =$ small effect; $\eta^2 > .06 =$ medium effect; and $\eta^2 > .14 =$ large effect) (Richardson, 2011).

In our study, participants were subdivided into five age groups. Table 1 shows the demographics of the final sample. In the second step, we studied the effects of age, gender, and education on WMQ domains to provide Italian norms for the five age ranges. In the third step, we determined the age-adjusted norms (means and standard deviations) of the following indicators for the WMQ: memory storage (total raw subscores: TRS); attention (total raw subscores: TRS) and executive functions (total raw subscores: TRS). To this end, the raw scores were first converted into percentile ranks for each age distribution. We used percentiles for their statistical properties that allow a universal interpretation. Indeed, the percentile ranks begin with a specific score or value and calculate the percentage of cases falling at or below it. However, we suggest caution and the use of single case statistics (Crawford & Howell, 1998; Crawford & Garthwaite, 2002) for groups fewer than 15 subjects, with the aim to overcome limitations due to the sample size (see Table 2).

Furthermore, we assessed the internal validity of the scale through the correlation between the raw subscores of three domains and the total raw score of the scale. Moreover, we computed the concurrent validity by using Spearman rank order correlation coefficients between the total raw score of the scale on the one hand and CFQ and the Raven Colored Progressive Matrices on the other hand. We also performed tests of the concurrent validity by using Spearman rank order correlation coefficients between the three subscores of the WMQ domains separately. Specifically, we assessed correlations between the memory storage subscores and the spans obtained in the Corsi test (forward and backward) and in the Digit Span test (forward and backward). We performed correlations between the attention subscores and the correct responses on the Visual Search and correlations between the executive functions subscores with the number of total words produced in the phonetic and semantic fluency tests and the total score obtained with the cards of the BADS.

**Results**

**Effect of demographic variables**

Table 1 shows the means and standard deviations for all demographic variables (age, gender and education) and the age midpoints of the groups subdivided by age. We subdivided the sample in five age groups, two gender groups and two educational level (high and low) groups (see the Subjects section for more demographic details regarding the subdivision).

By MANOVA, age and education showed main effects on the WMQ scores. More specifically, the following F values, p values, $\eta^2$ values, and observed power were obtained: age on the WMQ total score [$F_{(4, 19)} = 5.31, p = .001, \eta^2 = .303; \text{observed power } = .97$] and on the three domains [memory storage: $F_{(4, 19)} = 3.89, p = .023, \eta^2 = .17; \text{observed power } = .78$; education on the WMQ total score [$F_{(1, 19)} = 7.49, p = .006, \eta^2 = .11; \text{observed power } = .78$] and on two out of the three domains [memory storage: $F_{(1, 19)} = 11.22, p = .001, \eta^2 = .16; \text{observed power } = .92$; attention: $F_{(1, 19)} = 4.75, p = .030, \eta^2 = .07; \text{observed power } = .59$].

Gender showed no main effect.

No significant second level interactions of age x gender were found, while the second level interaction of age x education was significant on the WMQ total score [$F_{(4, 19)} = 3.26, p = .012, \eta^2 = .19; \text{observed power } = .84$], and on two out of the three domains [memory storage: $F_{(4, 19)} = 3.36, p = .010, \eta^2 = .19; \text{observed power } = .85$; attention: $F_{(4, 19)} = 3.75, p = .005, \eta^2 = .022; \text{observed power } = .89$]. Additionally, the gender x education second level interaction was lightly significant on the WMQ total score [$F_{(1, 19)} = 4.01, p = .046, \eta^2 = .06; \text{observed power } = .52$] and on one out of the three domains [executive function: $F_{(1, 19)} = 4.39, p = .037, \eta^2 = .066; \text{observed power } = .55$].
Finally, the age x gender x education third level interaction was significant on the WMQ total score \(F_{(4, 19)} = 2.81, \ p = .019, \ \eta^2 = .017; \) observed power \(= .80\) and on the memory storage domain only \(F_{(4, 19)} = 4.04, \ p = .003, \ \eta^2 = .023; \) observed power \(= .91\).

The post hoc analyses were performed using a separate t-test for independent age groups. The t-test performed for the second level interaction of age x education showed just one significant difference in the group 18–28 years. [WMQ total score: \(p = .001; \) low education: \(x = 40.26 (14.11)\) and high education: \(x = 29.69 (12.94);\) memory storage: \(p = 0.004; \) low education: \(x = 11.68 (4.95)\) and high education: \(x = 8.92 (5.02);\) attention: \(p = 0.001; \) low education: \(x = 14.71 (6.04)\) and high education: \(x = 10.60 (4.76)\) in which individuals with low education assess themselves as less proficient than individuals with high education. No significant differences emerged for the other four age groups (29–39 years, 40–50 years, 51–60 years, and 61–88 years). For the second level interaction of gender x education, the t-test did not show any significant difference, probably due to the very low observed power and effect of this interaction (see Figure 1).

For the three-level interactions, post hoc analyses were performed through univariate ANOVA for independent age groups (see Figure 2). In the 18–28 years, men with low education \(x = 43.14 (12.29)\) significantly differed \((p = 0.018)\) on the WMQ total score relative to the men with high education \(x = 30.75 (14.43)\) as well as \((p = 0.008)\) the women with high education \(x = 29.36 (11.98)\). Men with high education \(x = 30.75 (14.43)\) significantly differed \((p = 0.022)\) from women with low education \(x = 37.44 (14.94)\). Finally, women with low \(x = 37.44 (14.94)\) and high \(x = 29.36 (11.98)\)
education significantly differed \((p = 0.005)\) with each other. Concerning memory storage, men with high education \([x = 12.14 (6.62)]\) significantly differed \((p = 0.029)\) from women with low education \([x = 11.78 (5.53)]\), and women with low \([x = 11.78 (5.53)]\) and high \([x = 8.53 (4.90)]\) education significantly differed \((p = 0.002)\) from each other.

In the 40–50 years. group, men with low education \([x = 39.13 (10.93)]\) significantly differed \((p = 0.024)\) from men with high education \([x = 27.60 (14.13)]\) on the WMQ total score. With respect to the memory storage domain, men with low \([x = 13.93 (6.33)]\) and high \([x = 8.14 (6.38)]\) education significantly differed \((p = 0.005)\) from each other and from the women with high education \([x = 8.82 (5.89)]\) \((p = 0.004)\).

In the 61–88 years. group, men with low education \([x = 45.96 (17.30)]\) significantly differed from the other groups on the WMQ total score \([MH: p = 0.001; x = 30.67 (14.67); WL: p = 0.019; x = 35.83 (18.44); WH: p = 0.014; x = 34.96 (18.51)]\). Additionally, for the memory storage domain, men with low education \([x = 15.36 (6.88)]\) significantly differed from all groups \([MH: p = 0.001; x = 9.32 (5.09); WL: p = 0.008; x = 11.17 (6.92); WH: p = 0.004; x = 10.96 (6.85)]\).

There was an interaction of age \(x\) gender on the WMQ total score \([age \times gender: F_{(48, 330)} = 1.63, p = .007, \eta^2 = .176;\) observed power = .99\] and on the subscores of memory storage \([F_{(48, 330)} = 1.73, p = .003, \eta^2 = .185;\) observed power = 1\] and attention \([F_{(48, 330)} = 1.68, p = .004, \eta^2 = .181;\) observed power = 1\]. There was also an interaction of education \(x\) gender on the subscore of memory storage \([F_{(7, 330)} = 2.33, p = .02, \eta^2 = .043;\) observed power = .85\].

**Italian normative data**

We provided Italian norms for five age ranges, specifically for the three domains of the WMQ (memory

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**Figure 1.** Means of the second level interaction age \(x\) education for the memory storage, attention and executive function domains and for the Working Memory Questionnaire (WMQ).
storage, attention and executive function). Table 2 shows the means and standard deviations for the WMQ total score and for the three domains sub-scores, whereas Table 3 shows percentiles for the WMQ total score and the three domains.

To assess the internal validity of the WMQ, the correlations between the three domains and the total score of the WMQ were computed.

The total scores of the WMQ were significantly correlated ($p < .001$) with the scores of each of the three domains (memory storage: $r = .886$; attention: $r = .901$; executive function = .874). The memory storage scores were significantly correlated with the attention scores ($r = .708; p < .001$) and scores for the executive functions ($r = .663; p < .001$). The attention scores were also significantly correlated with scores for the executive functions ($r = .704; p < .001$). These data demonstrate a high internal validity of the questionnaire.

To assess the concurrent validity, Pearson correlations were computed between the WMQ total scores, the subscores of the three domains and the cognitive measures. The WMQ total score was significantly correlated with all cognitive measures except with the fCBT and bCBT.

In particular, the high negative correlation with the CPM ($r = -.129; p < .001$) demonstrates an agreement between the self-evaluation of the WMQ (in which low scores correspond to a good self-perception of one’s own general capacity) and a fluid intelligence (in which high scores correspond to a good performance). The high positive correlation with the CFQ ($r = .511; p < .001$) demonstrates an agreement between two measures of self-evaluation to fail in daily life.

Concerning the memory storage domain and the cognitive measures, the memory storage scores significantly correlated with all cognitive measures except for the fCBT, bCBT, and the rule shift cards. Specifically, the high negative correlation with memory storage and fDS and bDS demonstrates that fewer self-reported complaints in memory functioning are associated with higher verbal auditory span (fDS: $r = -.118; p < .001$; bDS: $r = -.096; p < .05$).

**Figure 2.** Means of the third level interaction age x gender x education for the memory storage, attention and executive function domains and for the Working Memory Questionnaire (WMQ).
The attention scores significantly correlated with all cognitive measures except for the fDS and fCBT. In particular, the high negative correlation with visual search test scores ($r = -0.181; p < 0.001$) demonstrates that fewer self-reported attentional problems correspond with better performance in a Selective Attention task. The executive functions score significantly correlated with the CFQ, CPM, Word fluency test, and Visual search test. As we expected, the high negative correlation with word fluency (phonetic $r = -0.200; p < 0.001$; semantic: $r = -0.255; p < 0.001$) demonstrates that fewer reported problems in executive functions corresponds to a higher capacity to access the lexicon with a time constraint. Here, we did not find any correlation with the Rule Shift Cards; this may represent a specific aspect of the executive functions that is probably not self-assessed through the questionnaire (see Table 4 for details).

We also analyzed the WMQ performance of the 28 individuals who had been excluded from the normative sample due to their performance on the MMSE. For these individuals, we computed z-scores to assess whether their performance on the WMQ was also deficient. From this group, 4 individuals were in the 40–50 years group; only 3 individuals fell in the 51–60 year group and the remaining 21 individuals fell in the 61–88 year group. Testing revealed that 4 individuals had a pathological WMQ total score, 7 had a pathological score in the memory storage domain, 5 individuals had a pathological score in the attention domain and 4 individuals had a pathological score in the executive functions domain (for details, see Table 5).

**Discussion**

The availability of valid self-report measures in neuropsychology is important to subjectively evaluate the difficulties encountered by patients in their everyday life, as well as to help clinicians in decision-making regarding issues such as distinguishing the first symptoms of cognitive decline versus symptoms related to late-onset depression or to monitor patients with mild traumatic brain injuries that may notice some difficulties only some of the time after the injury and they are back to their daily activities. Indeed, some studies have highlighted that traditional tests have a minimal connection with everyday life, and they are not

### Table 3. Percentiles

| Percentile | 18–28 years | 29–39 years | 40–50 years | 51–60 years | 61–88 years |
|------------|-------------|-------------|-------------|-------------|-------------|
| Memory storage | | | | | |
| 5th | M | W | M | W | M | W | M | W | M | W |
| 10th | M | W | M | W | M | W | M | W | M | W |
| 25th | M | W | M | W | M | W | M | W | M | W |
| 50th | M | W | M | W | M | W | M | W | M | W |
| 90th | M | W | M | W | M | W | M | W | M | W |
| 95th | M | W | M | W | M | W | M | W | M | W |
| Attention | | | | | |
| 5th | M | W | M | W | M | W | M | W | M | W |
| 10th | M | W | M | W | M | W | M | W | M | W |
| 25th | M | W | M | W | M | W | M | W | M | W |
| 50th | M | W | M | W | M | W | M | W | M | W |
| 90th | M | W | M | W | M | W | M | W | M | W |
| 95th | M | W | M | W | M | W | M | W | M | W |
| Executive functions | | | | | |
| 5th | M | W | M | W | M | W | M | W | M | W |
| 10th | M | W | M | W | M | W | M | W | M | W |
| 25th | M | W | M | W | M | W | M | W | M | W |
| 50th | M | W | M | W | M | W | M | W | M | W |
| 90th | M | W | M | W | M | W | M | W | M | W |
| 95th | M | W | M | W | M | W | M | W | M | W |
| Total score WMQ | | | | | |
| 5th | M | W | M | W | M | W | M | W | M | W |
| 10th | M | W | M | W | M | W | M | W | M | W |
| 25th | M | W | M | W | M | W | M | W | M | W |
| 50th | M | W | M | W | M | W | M | W | M | W |
| 90th | M | W | M | W | M | W | M | W | M | W |
| 95th | M | W | M | W | M | W | M | W | M | W |

**Notes.** In the table, percentiles for the groups subdivided by age (18–28 years; 29–39 years; 40–50 years; 51–60 years; 61–88 years) and gender ($M = $ men, $W = $ women) in the three subscales (memory storage, attention, and executive functions), as well as the total score of WMQ (Working Memory Questionnaire) are reported.
Table 4. Pearson correlation between the WMQ, its subscales and cognitive testing.

| Phonetic Fluency | Semantic Fluency | CPM | fDS | bDS | FCBT | bCBT | Rules shift cards | Visual Search Test |
|------------------|------------------|-----|-----|-----|------|------|------------------|-------------------|
| Memory storage   | .511**           | −.266** | −.254** | −.125** | −.118** | −.096* | −.045 | −.035 | −.069 | −.156** |
| Attention        | .504**           | −.192** | −.249** | −.103** | −.068 | −.083* | −.069 | −.092* | −.094* | −.181** |
| Executive functions | .512**       | −.200** | −.235** | −.191 | −.039 | −.047 | .005 | −.054 | −.046 | −.095* |
| Total score WMQ  | .572**           | −.244** | −.273** | −.129** | −.085* | −.085* | −.044 | −.068 | −.079* | −.166** |
| CFQ              | 1.000            | −.104* | −.093* | −.114** | −.059 | −.055 | −.041 | 1.047 | −.052 | −.049 |
| Phonetic fluency | 1.000            | 1.000  | .659** | .377** | .234** | .208** | .149** | .142** | .318** | .245** |
| Semantic fluency | 1.000            | .229** | .172** | .046 | .095* | .146** | .301** | .194** |
| CPM              | 1.000            | .351** | .122** | .330** | .283** | .359** | .348** |
| fDS              | 1.000            | .124** | .416** | .224** | .247** | .249** |
| bDS              | 1.000            | .166** | .132** | .248** | .033  |
| FCBT             | 1.000            | .353** | .287** | .201** |
| bCBT             | 1.000            | .251** | .199** |

Notes. CFQ = Cognitive failures questionnaire; WMQ = working memory questionnaire; CPM = Raven’s Colored Progressive Matrices; fDS = forward digit span; bDS = backward digit span; FCBT = forward Corsi block-tapping test; bCBT = backward Corsi block-tapping test. Pearson correlation coefficients.

**p < .01.
*p < .05.

Table 5. Z-scores of WMQ of cases with pathological MMSE scores.

| Memory storage | Attention | Executive functions | WMQ total score |
|----------------|-----------|---------------------|-----------------|
| 40–50 years    |           |                     |                 |
| Case 1 (M-L)   | 1.75      | 1.98                | 1.46            |
| Case 2 (M-H)   | −.76      | −.66                | −.10            |
| Case 3 (W-L)   | 0.75      | 1.02                | 1.24            |
| Case 4 (W-H)   | −.82      | −.17                | −.86            |
| Case 5 (M-H)   | 0.79      | 0.17                | 0.61            |
| Case 6 (W-L)   | 0.42      | 0.74                | 0.18            |
| Case 7 (W-L)   | 3.13      | 1.06                | 2.43            |
| 51–60 years    |           |                     |                 |
| Case 8 (M-L)   | 0.97      | 1.01                | 0.76            |
| Case 9 (M-L)   | −.54      | −.12                | −.97            |
| Case 10 (M-L)  | −.06      | 0.39                | −.04            |
| Case 11 (M-L)  | 0.38      | 0.89                | −.45            |
| Case 12 (M-L)  | 0.38      | 0.77                | 0.07            |
| Case 13 (M-L)  | 0.08      | −.13                | −.32            |
| Case 14 (M-L)  | −.36      | −.35                | −.15            |
| Case 15 (M-L)  | 0.97      | 1.51                | 1.45            |
| Case 16 (M-L)  | 0.82      | 0.89                | 0.59            |
| Case 17 (M-L)  | 0.08      | 1.01                | 0.41            |
| Case 18 (M-L)  | 0.67      | 1.76                | 1.45            |
| Case 19 (M-L)  | −.21      | 0.39                | −.80            |
| Case 20 (M-H)  | 1.70      | 1.01                | 1.51            |
| Case 21 (W-L)  | 2.55      | 0.08                | −.12            |
| Case 22 (W-L)  | 0.23      | 1.27                | −.057           |
| Case 23 (W-L)  | 1.72      | 0.08                | −.28            |
| Case 24 (W-L)  | 1.06      | 0.93                | 0.56            |
| Case 25 (W-L)  | 1.72      | 1.60                | 0.73            |
| Case 26 (W-L)  | 0.73      | −.25                | 0.39            |
| Case 27 (W-L)  | 2.55      | 2.96                | 2.07            |
| Case 28 (M-H)  | −.68      | −0.64               | −0.80           |

Notes. Z-scores of WMQ (working memory questionnaire) and its subscales for the 28 cases excluded from normative data for their performance on the MMSE. In bold, the pathological z-score. M-L (man with low education); M-H (man with high education); W-L (woman with low education); and W-H (woman with high education).

Effective in predicting difficulties met in the daily life when the patient comes back home after discharge from the hospital or in detecting the first symptoms of cognitive decline in older people (e.g., Bottari et al., 2009; Manchester et al., 2004).

Therefore, although standard testing and investigations are indispensable for diagnosis, a self-report questionnaire investigating working memory and its three domains (memory, attention, and executive functions) could be useful to clinicians to better address assessment as well as to recognize some patients’ memory difficulties and distinguish between different aspects of these deficits (i.e., attentional disorders or executive function deficits as well as memory drops tout court).

Our results showed that the Italian version of the WMQ has a high internal validity, since each domain strongly correlates with each other and with the total score. Furthermore, we also found a high concurrent validity, since the performance on the WMQ.
significantly correlated with the cognitive tests that measure reasoning, working memory and attention but not with a measure of executive functions. However, it is noteworthy that executive functions are engaged throughout various cognitive tasks (Fedorenko, Duncan, & Kanwisher, 2013) and include several distinguishable aspects (such as attentional control, monitoring, planning, problem solving, cognitive flexibility, cognitive inhibition, etc.; Diamond, 2013; Chan, Shum, Touloupoulou, & Chen, 2008). Therefore, it is possible that the executive functions involved in the working memory relevant to everyday life involved aspects of monitoring and speed of information processing more than other aspects that are assessed with other tests. For this reason, we found a correlation with fluency but not with the rule shift card test that taps into shifting and flexibility that are less important in the executive functions involved in working memory and measured by the WMQ.

Concerning memory storage, we found a high correlation with the auditory component measured by forward and backward DS but not with the visuospatial component of working memory measured by CBT; examination of the relevant specific items reveals that they all concern the verbal working memory domains, and for this reason, the memory storage domain correlates with DS and not with CBT.

Similar to the original French version of the WMQ, we did not find main effects due to gender, but we found effects due to differences in age and educational level. Specifically, we observed that the score gradually increases with advancing age; however, as in the French standardization, we also observed that younger participants (aged 18–28 years) had more complaints than other age groups. Vallat-Azouvi et al. (2012) did not offer an explanation for this effect, and they hypothesized a chance effect. However, if this effect is also present in our sample, an explanation should be attempted. A possible explanation could be related to the fact that in this age range, many individuals are attending university courses, postgraduate master’s degrees, and master’s classes, and some of them are entering the job market where their memory skills are tested. It could not be a coincidence that only in this age range is there a significant interaction between age and education. Specifically, young people with a low education level that may have dropped out of school due to more general difficulties may self-perceive their memory, attention, and executive functions as less effective than the self-perception of young people with a high education level. Another main effect that we found, also observed by Vallat-Azouvi et al. (2012), was that people with low education tended to complain more with respect their memory and attention skills. In this case as well, it is possible that low education may have an effect on self-esteem and self-efficacy of cognitive abilities.

In general, aging has been associated with declines in some cognitive functions, among them working memory, attention, and executive functions, which are also related to anatomical and functional neural changes (e.g., Salthouse, 2010, 2011; Hale et al., 2011; Iachini, Iavarone, Senese, Ruotolo, & Ruggiero, 2009).

However, it is noteworthy that we found a significant interaction of age, gender, and education that deserves to be interpreted. In general, men with low education self-estimated as less proficient than men and women with high education, and this was more evident for the youngest and the oldest. This is quite different from the body of evidence that reports women having a low self-esteem with respect to men (e.g., Nori & Piccardi, 2015). These data typically concern the abilities in which there is a strong sex-stereotype effect, such as visuo-spatial skills, and not verbal skills with which women feel more confident. Therefore, since the WMQ measures more verbal-related memory storage, attention, and executive functions, processes in which women rate themselves and perform better than men (e.g., Palermo et al., 2016), the sex-stereotype effect did not emerge, and, in fact, the reversed effect appeared.

According to Park et al. (2002), who have compared groups of younger (ages 20–49) and older (ages 60–89) adults, the working memory structure remains stable, while the individual abilities (e.g., the visuospatial and verbal components), as well as memory storage and executive components, decline with the age. Taking this dispute into account and applying different weights on attention, memory storage, and executive functions, we provided separate cutoff values for the three domains, and not only for the WMQ total score, to allow clinicians to address the following structured evaluation when it comes to self-complaints by the subject. For the Italian WMQ, differently from the French version, we provided normative data with the perspective that this questionnaire can be used as a prescreening tool. Indeed, despite of the increasing public awareness to inform people regarding cognitive decline, there are still barriers to its early detection (van Vliet et al., 2013; Draper et al., 2016). The WMQ could be a useful instrument to self-evaluate memory functioning. It could become a red flag indicating potential mild cognitive impairments in the working memory domain, and it could be introduced as a
good practice for the mental health of elderly people. Use of a standardized instrument may be helpful for not underestimating the memory deficits or misattributing them to other life factors that may or may not be relevant in this situation. For example, memory efficiency changes during the lifespan and some changes are normal that may be a reaction to stressful life events, but in other cases, the memory changes or deficits may mask subtle cognitive changes due to executive functioning and not memory tout court.

The present study has some limitations. First, we did not collect a measure of other psychological disorders (i.e., late-life depression) that may have affected performance on the cognitive tests and, in particular, on the memory tests. Another limitation was the absence of a group of patients with brain injury or memory loss to demonstrate the utility of such self-report measure in detecting subtle disorders. However, the presence of a small group of subjects with a performance below the MMSE cutoff allowed us to endorse the use of this instrument in individuals who did not seek mental help, but they have already some cognitive problems detectable in a preliminary screening for dementia.

An examination of their performance both on the WMQ and on the other cognitive tests seemed to suggest for some of them that their complaints on their memory function also mirrors their cognitive performance.

However, the fact that not all individuals with an MMSE under the cutoff value self-report memory problems suggested that self-assessed measures must be supported with a structured neuropsychological battery of tests. At this point, no conclusions can be drawn by such a small sample of pathological individuals without a certain diagnosis. Additional research is needed to assess the psychometric properties in clinical samples and identify specific problems reported by patients with different pathologies and their caregivers.

In conclusion, the present study demonstrated that the Italian version of the WMQ is reliable and valid for assessing different aspects of working memory.

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**References**

Albert, M. S., DeKosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C., … Phelps, C. H. (2011). The diagnosis of mild cognitive impairment due to Alzheimer’s disease: recommendations from the National Institute on Aging-Alzheimer’s Association workgroups on diagnostic guidelines for Alzheimer’s disease. *Alzheimer’s Dementia, 7*(3), 270–279. doi:10.1016/j.jalz.2011.03.008

Antonacci, G., Spitonì, G., Orsini, A., D’Olimpio, F., & Cantagallo, A. (2014). Taratura Italiana della Batteria per la valutazione della Sindrome Dissessicattiva: BADS. Florence, Italy: Giunti O.S., Organizzazioni Speciali.

Baddeley, A. (2000). The episodic buffer: a new component of working memory? *Trends in Cognitive Science, 4*(11), 417–423. doi:10.1016/S1364-6613(00)01538-2

Baddeley, A. D., Bres, S., Della Sala, S., Logie, R., & Spinnler, H. (1991). The decline of working memory in Alzheimer’s disease. A longitudinal study. *Brain, 114*(6), 2521–2542. doi:10.1093/brain/114.6.2521

Baddeley, A., & Hitch, G. (1974). The psychology of learning and motivation: Advances in Research and Theory. In G. H. Bower (eds). *Working Memory. The psychology of learning and motivation* (pp. 47–89). New York: Academic Press.

Basso, A., Capitani, E., & Laiacona, M. (1987). Raven’s coloured progressive matrices: Normative values on 305 adult normal controls. *Functional Neurology, 2*, 189–194.

Bolla, K., Lindgren, K., Bonaccorsy, C., & Bleecker, M. L. (1991). Memory complaints in older adults. Fact or fiction? *Archives of Neurology, 48*(1), 61–64.

Bottari, C., Dassa, C., Rainville, C., & Dutil, E. (2009). The criterion-related validity of the IADL profile with measures of executive functions, indices of trauma severity and sociodemographic characteristics. *Brain Injury, 23*(4), 322–335. doi:10.1080/02699050902788436

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21*(1), 1–16. doi:10144-6657/82/010001-16 $22.00/0.

Capitani, E., Laiacona, M., & Barbarotto, R. (1999). Gender affects word retrieval of certain categories in semantic fluency tasks. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 35*(2), 273–278.

Chan, R. C., Shum, D., Toulouropoulos, T., & Chen, E. Y. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology, 23*(2), 201–216. doi:10.1016/j.acn.2007.08.010

Chaytor, N., & Schmitter-Edgecombe, M. (2003). The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. *Neuropsychology Review, 13*(4), 181–197. doi:10.1023/B:NERV.0000000483.91468.fb

Chaytor, N., Schmitter-Edgecombe, M., & Burr, R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology, 21*(3), 217–227. doi:10.1016/j.acn.2005.12.002

Corsi, P. M. (1972). *Human memory and the medial temporal region of the brain.* (Ph.D. Dissertation). McGill University.

Crawford, J. R., & Garthwaite, P. H. (2002). Investigation of the single case in neuropsychology: Confidence limits on the abnormality of test scores and test score differences.
Neuropsychologia, 40(8), 1196–1208. doi:10.1016/S0028-3932(01)00224-X
Crawford, J. R., & Howell, D. C. (1998). Comparing an individual’s test score against norms derived from small samples. The Clinical Neuropsychologist, 12(4), 482–486. doi:10.1076/clin.12.4.482.7241
Cutler, S. J., & Grams, A. E. (1988). Correlates of self-reported everyday memory problems. Journal of Gerontology, 43(3), 582–590.
De Beni, R., Borella, E., Carretti, B., Marigo, C., & Nava, L. A. (2007). BAC: Benessere Attitudine Cognitiva nell’età Adulta e Avanzata. [BAC: Wellness and cognitive abilities in the advanced and adult age]. Florence, Italy: Giunti O.S., Organizzazioni Speciali.
Diamond, A. (2013). Executive functions. Annual Review of Psychology, 64(1), 135–168. doi:10.1146/annurev-psych-110311-143750
Draper, B., Cations, M., White, F., Trollor, J., Loy, C., Brodaty, H., … Withall, A. (2016). Time to diagnosis in young-onset dementia and its determinants: The INSPIRED study. International Journal of Geriatric Psychiatry, 31(11), 1217–1224. doi:10.1002/gps.4430
Fedorenko, E., Duncan, J., & Kanwisher, N. (2013). Broad domain generality in focal regions of frontal and parietal cortex. Proceedings of the National Academy of Sciences, 110(41), 16616–16621. doi:10.1073/pnas.1315235110
Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”: a practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12(3), 189–198. doi:10.1016/0022-3956(75)90026-6
Franzen, M. D., & Arnett, P. A. (1997). The validity of neuropsychological assessment procedures. In H. W. Reese, and M. D. Franzen, (eds.), Biological and neuropsychological mechanisms: Life-span developmental psychology, (pp. 51–69). Mahwah, NJ: Erlbaum.
Frisoni, G. B., Rozzini, R., Bianchetti, A., & Trabucchi, M. (1993). Principal lifetime occupation and MMSE score in elderly persons. Journal of Gerontology, 48(6), S310–S314. doi:10.1093/geronj/48.6.S310
Geerlings, M. I., Jonker, C., Boutier, L. M., Ader, H. J., & Schmand, B. (1999). Association between memory complaints and incident Alzheimer’s disease in elderly people with normal baseline cognition. American Journal of Psychiatry, 156, 531–537. doi:10.1176/ajp.156.4.531.
Hale, S., Rose, N. S., Myerson, J., Strube, M. J., Sommers, M., Tye-Murray, N., & Spehar, B. (2011). The structure of working memory abilities across the adult life span. Psychology and Aging, 26(1), 92. doi:10.1037/a0021483.
Heinrichs, R. W. (1990). Current and emergent applications of neuropsychological assessment: Problems with validity and utility. Professional Psychology: Research and Practice, 21(3), 171–176. doi:10.1037/0735-7082.21.3.171
Iachini, T., Iavarone, A., Senese, V. P., Ruotolo, F., & Ruggiero, G. (2009). Visuospatial memory in healthy elderly, AD and MCI: a review. Current Aging Science, 2(1), 43–59. doi:10.2174/1874609810902010043.
Jorm, A. F., Christensen, H., Henderson, A. S., Korten, A. E., Mackinnon, A. J., & Scott, R. (1994). Complaints of cognitive decline in the elderly: a comparison of reports by subjects and informants in a community survey. Psychological Medicine, 24(02), 365–374. doi:10.1017/S0033291700027343
Lin, M. R., Chiu, W. T., Chen, Y. J., Yu, W. Y., Huang, S. J., & Tsai, M. D. (2010). Longitudinal changes in the health-related quality of life during the first year after traumatic brain injury. Archives of Physical Medicine and Rehabilitation, 91(3), 474–480. doi:10.1016/j.apmr.2009.10.031
Logie, R. H., Cocchini, G., Delia Sala, S., & Baddeley, A. D. (2004). Is there a specific executive capacity for dual task coordination? Evidence from Alzheimer’s disease. Neuropsychology, 18(3), 504–513. doi:10.1037/0894-4105.18.3.504
Magni, E., Binetti, G., Bianchetti, A., Rozzini, R., & Trabucchi, M. (1996). Mini-mental state examination: A normative study in Italian elderly population. European Journal of Neurology, 3(3), 198–202. doi:10.1111/j.1368-1331.1996.tb00423.x.
Manchester, D., Priestley, N., & Howard, J. (2004). The assessment of executive functions: Coming out of the office. Brain Injury, 18(11), 1067–1081.
Matthews, G., Coyle, K., & Craig, A. (1990). Multiple factors of cognitive failure and their relationship with stress vulnerability. Journal of Psychopathology and Behavioral Assessment, 12(1), 49–65. doi:10.1007/BF00960453
Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howarter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal Lobe” tasks: A latent variable analysis. Cognitive Psychology, 41(1), 49–100. doi:10.1006/cogp.1999.0734
Miyake, A., & Shah, P. (1999). Models of working memory. Mechanisms of active maintenance and executive control. Cambridge, University Press.
Monaco, M., Costa, A., Caltagirone, C., & Carlesimo, G. A. (2013). Forward and backward span for verbal and visuo-spatial data: standardization and normative data from an Italian adult population. Neurological Sciences, 34(5), 749–754. doi:10.1007/s10072-012-1130-x
Montejo, P., Montenegro, M., Fernandez, M. A., & Maestu, F. (2011). Subjective memory complaints in the elderly: Prevalence and influence of temporal orientation, depression and quality of life in a population-based study in the city of Madrid. Aging and Mental Health, 15, 85–96. doi:10.1080/13607863.2010.501062
Norri, R., & Piccardi, L. (2015). I believe I’m good at orienting myself… But is that true? Cognitive Processing, 16 (3), 301–307.
Novelli, G., Papagno, C., Capitani, E., Laiacona, M., Vallar, G., & Cappa, S. F. (1986). Tre test clinici di ricerca e produzione lessicale. Taratura su soggetti normali. Archivio di Psicologia, Neurologia e Psichiatria, 47, 477–506.
Orsini, A. (2003). La memoria diretta e la memoria inversa di cifre in soggetti dai 16 ai 64 anni. Bollettino di Psicologia Applicata, 239, 73–77.
Orsini, A., Grossi, D., Capitani, E., Laiacona, M., Papagno, C., & Vallar, G. (1987). Verbal and spatial immediate memory span: normative data from 1355 adults and 1112 children. Italian Journal of Neurological Science, 8, 539–548. doi:10.1007/BF02333660.
Palermo, L., Cinelli, M. C., Piccardi, L., Ciurlì, P., Incoccia, C., Zompanti, L., & Guariglia, C. (2016). Women
outperform men in remembering to remember. *The Quarterly Journal of Experimental Psychology, 69*(1), 65–74. doi:10.1080/17470218.2015.1023734

Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and Aging, 17*(2), 299–320. doi:10.1037/0882-7974.17.2.299.

Piccardi, L., Bianchini, F., Argento, O., De Nigris, A., Mamaletti, A., Palermo, L., & Guariglia, C. (2013). The Walking Corsi Test (WalCT): Standardization of the topographical memory test in an Italian population. *Neurological Sciences, 34*(6), 971–978. doi:10.1007/s10072-012-1175-x

Piccardi, L., Magnotti, L., Tanzilli, A., Aloisi, M., & Guariglia, P. (2016). Is the patient able to watch TV or read the newspaper? A functional semi-structured scale to observe Hemineglect symptoms in Activities of Daily Living (H-ADL). *Appl Neuropsychol Adult, 23*(6), 418–425. doi:10.1080/23279095.2016.1167692

Pollina, L. K., Greene, A. L., Tunick, R. H., & Puckett, J. M. (2011). Eta squared and partial eta squared as measures of effect size in educational research. *Educational Research Review, 6*(2), 135–147. doi:10.1016/j.edurev.2010.12.001

Salmaso, D., & Viola, G. (1989). Valutazione e autovalutazione nell’invecchiamento cognitivo. [Assessment and self-assessment in the cognitive ageing]. *Argomenti di Gerontologia, 1*, 33–36.

Saltzhouse, T. A. (2010). Selective review of cognitive aging. *Journal of the International Neuropsychological Society, 16*(05), 754–760. doi:10.1017/S1355617710000706

Saltzhouse, T. A. (2011). Neuroanatomical substrates of age-related cognitive decline. *Psychological Bulletin, 137*(5), 753–784. doi:10.1037/a0023262

Sbordone, R. J. (2008). Ecological validity of neuropsychological testing: Critical issues. In A. M. Horton & D. Wedding (eds.), *The neuropsychology handbook* (3rd ed., pp. 367–394). New York: Springer.

Spinnler, H., & Tognoni, G. (1987). Standardizzazione e taratura italiana di test neuropsicologici. *The Italian Journal of Neurological Sciences, 8*, 44–46.

Stratta, P., Rinaldi, O., Daneluzzo, E., & Rossi, A. (2006). Utilizzo della versione italiana del Cognitive Failures Questionnaire (CFQ) in un campione di studenti: uno studio di validazione. [The use of the italian version of the Cognitive Failures Questionnaire (CFQ) in a sample of undergraduate students: a validation study]. *Rivista di Psichiatria, 41*, 260–265.

Tupper, D., & Cicerone, K. (1990). Introduction to the neuropsychology of everyday life. In: D., Tupper, and C. Cicerone, (eds.), *The neuropsychology of everyday life: Assessment and basic competencies*, (pp. 3–18). Boston, MA: Kluwer Academic.

Vallat-Azouvi, C., Pradat-Diehl, P., & Azouvi, P. (2012). The Working Memory Questionnaire: A scale to assess everyday life problems related to deficits of working memory in brain injured patients. *Neuropsychological Rehabilitation, 22*(4), 634–649. doi:10.1080/09602011.2012.681110

Van Vliet, D., de Vugt, M. E., Bakker, C., Pijnenburg, Y. A. L., Vernooij-Dassen, M. J. F. J., Koopmans, R. T. C. M., & Verhey, F. R. J. (2013). Time to diagnosis in young-onset dementia as compared to late-onset dementia. *Psychological Medicine, 43*(02), 423–432. doi:10.1017/S0033291712001122

Vannini, P., Hanseeuw, B., Munro, C. E., Amariglio, R. E., Marshall, G. A., Rentz, D. M., … Sperling, R. A. (2017). Hippocampal hypometabolism in older adults with memory complaints and increased amyloid burden. *Neurology, 88*(18), 1759–1767. doi:10.1212/WNL.0000000000003889

Wagle, A. C., Berrios, G. E., & Ho, L. (1999). The cognitive failure questionnaire in psychiatry. *Comprehensive Psychiatry, 40*(6), 478–484. doi:10.1016/S0010-440X(99)00093-7

Wallace, J. C., Kass, S. J., & Stanny, C. J. (2002). The cognitive failures questionnaire: Dimensions and correlates. *The Journal of General Psychology, 129*(3), 238–256. doi:10.1080/0022126X.2009.484330

Wechsler, D. (1981). *Manual for the Wechsler Adult Intelligence Scale-Revised*. New York, NY: Psychological Corporation.

Wilson, B. A., Alderman, N., Burgess, P. W., Emslie, H., & Evans, J. J. (1996). *Behavioural assessment of the dysexecutive syndrome*. St Edmunds, UK, Thames Valley Test Company.

Wongupparaj, P., Kumari, V., & Morris, R. G. (2015). The relation between a multicomponent working memory and intelligence: The roles of central executive and short-term storage functions. *Intelligence, 53*, 166–180. doi:10.1016/j.intell.2015.10.007