Fund of Information is More Strongly Associated with Neuropsychological Functioning Than Education in Older Spanish Adults

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Abstract

Educational influence on cognitive performance has been extensively agreed in Neuropsychology. Nonetheless, recent studies highlighted the need of better measurements to assess benefit from the schooling experience in order to further understand schooling influence on cognition. The WAIS-III Information subtest is proposed here to measure this influence at old age. Ninety-five older adults were divided according to their educational attainment and their Information subtest score, and completed extensive neuropsychological assessment. Performance on the Information subtest had a significant effect on all same cognitive functions as educational attainment, but also on additional domains. Moreover, cognitive performance on several tasks can be classified in three levels as a function of Information score. The WAIS-III Information subtest could be of special interest as a measurement of the benefit from educational experience not only to study cognition in Spanish older populations but also heterogeneous samples in terms of educational experiences and environments.

Keywords: Assessment; Elderly/geriatrics/aging; Cross-cultural/minority; Norms/normative studies

Introduction

People experience both physical and cognitive changes as they age. There has been a considerable amount of research into the study of age-related cognitive changes over the last 100 years and this has resulted in a large quantity of published material. Although findings about cognition in normal aging are heterogeneous and sometimes seem contradictory, there is a set of factors that might explain this heterogeneity. These factors modulate the probability of occurrence of age-related cognitive decline by playing a protective or facilitator role in terms of damage risk. Factors that have received most attention are global health status (e.g., cardiovascular risk, diabetes, etc.), genetic factors (APOE e4), physical and intellectual activity, and demographic factors (e.g., education and gender) (Bäckman et al., 2004; Christensen, 2001; Hedden & Gabrieli, 2004).

The influence of intellectual stimulation on the preservation of cognitive functioning in normal aging has attracted much attention. In this sense, the role of schooling as a protective factor against the clinical manifestation of neurodegenerative diseases associated with aging, especially Alzheimer’s disease, has been widely described (Brayne et al., 2010; Breteler, Claus, Grobbee, & Hofman, 1994; Caamano-Isorna, Corral, Montes-Martinez, & Takkouche, 2006; Karp, 2004; Letenneur et al., 1999; Lindsay, 2002; Mortimer, Snowdon, & Markesbery, 2003; Ott, Breteler, & Harskamp, 1995). In regard to normal cognitive aging Ardila and Rosselli (1989), reported that education is even more influential on neuropsychological performance than age itself. In addition, education influence on cognitive performance has been extensively agreed not only in neuropsychological research but also in everyday clinical neuropsychology practice. Most widespread neuropsychological tests include education as a correcting factor for patients’ scores or as a modulating factor in scores interpretation (Lezak, Howieson, Bigler, & Tranel, 2012). Nonetheless, some recent studies failed to find a significant schooling influence on cognitive functioning in normal aging (Van...
Dijk, Van Gerven, Van Boxtel, Van der Elst, & Jolles, 2008) or age-related cognitive decline (Zahodne et al., 2011), which leaves both, researchers and clinicians, with an unresolved question with highly relevant consequences for their practice.

Among other variables that could be explaining this heterogeneity in results about the schooling influence on cognitive aging, we find particularly interesting the discussion about whether most common schooling measurements, such as educational attainment and years of formal education, truly represent achievement and benefit from the schooling experience or other measurements should be pursued. In this sense, there is a remarkable set of studies carried out by Manly and colleagues (Manly, Jacobs, Sano, & Bell, 1999; Manly, Jacobs, Tourajdi, Small, & Stern, 2002; Manly, Tourajdi, Tang, & Stern, 2003; Manly, Byrd, Tourajdi, & Stern, 2004) that highlights the fact that not all individuals who have reached a certain grade level have achieved the same amount of learning, and that not the whole educational experience comes from the years of formal schooling.

Manly’s approach could be particularly suitable when studying schooling influence on cognition in normal aging, since there are still many places across the World where current older adults accessed highly unequal and very unstable education systems where education was neither a right nor a duty. This is the case of Spain (Liebano-Collado, 2009; Lozano-Seijas, 1995), among many other countries (Shavit & Blossfeld, 1993). Taking this into account it does not seem appropriate to consider, for example, that a person who attended to a resourceful school in a big city has had the same benefit from her educational experience than a person who attended to a rural one-room school, even if they both attended school the same number of years.

Literacy measurements such as reading skills have been proposed as a better alternative than years of formal school or educational attainment (Manly et al., 1999, 2002; Stern, 2003). However, the phonetic regularity of the Spanish language makes most literacy tests unsuitable for this purpose (Del Ser, Gonzalez-Montalvo, Martinez-Espinosa, Delgado-Villapalos, & Bermejo, 1997; Nurss, Baker, Davis, Parker, & Williams, 1995), and adaptations such as word accentuation tests need to be validated to the particular Spanish-speaking population being studied (Burin, Jorge, Arizaga, & Paulsen, 2000; Krueger, Lam, & Wilson, 2006).

In this sense, the WAIS-III information subtest (Wechsler, 1997a) is proposed here as a suitable measure of achievement and benefit from the schooling experience. The WAIS-III information subtest tends to reflect not only formal education but also motivation for academic achievement or interest (Lezak et al., 2012). In addition, information is one of the WAIS subtests showing the least decline with aging in normative samples (Lezak et al., 2012). According to some analyses using data from the USA standardization of the WAIS-IV, the information subtest even follows a significant positive linear age trend, although it also seems to fit a cubic trend, with an initial dip followed by a rise and later slow decline (Salthouse, 2009). Even though longitudinal studies are needed to deeply understand how performance on the information subtest changes with age, further cross-sectional analyses support relative stability of the information scores in the ageing process, showing non-significant difference between adults from 16 to 64 years of age and adults from 65 to 90 years in this subtest (Salthouse & Saklofske, 2010). Taking this evidence into consideration, we expect the information subtest to be a better estimate than years of schooling or formal educational attainment for measuring the influence that the educational experience has on cognitive performance in normal old age. To the best of our knowledge, this has not been tested before.

Thus, the goal of the present work is to compare the relationship that both formal education attainment and the information subtest have with the cognitive performance of older Spanish individuals. We believe that performance on the WAIS-III information subtest explains more variance in cognitive performance than formal schooling measures. Thus, we expect to find different levels of cognitive performance based on the information subtest score. In other words, we expect the information subtest to be a better tool to detect differences related to the schooling experience on cognition in old age.

Methods

Participants

The initial sample consisted of 148 unpaid volunteers who were recruited from different public health-care centers via their local GP’s referral. The recruitment criteria were as follows: first, healthy older adults from 60 to 80 years of age and secondly, apparent preserved cognitive and functional status. All the participants were native Spanish speakers from Spain (Europe).

Participants were screened in a semi-structured interview in order to exclude subjects showing neurologic or psychiatric disorders, systemic diseases with neuropsychological consequences, or substance abuse history. In this step, participants were also assessed with the Mini-Mental State Examination—MMSE (Folstein, Folstein, & McHugh, 1975), the Blessed Dementia Scale—BDS (Blessed, Tomlinson, & Roth, 1968), the Functional Activity Questionnaire—FAQ (Pfeffer, Kurosaki, Harrah, Chance, & Filos, 1982), and the short version of the Geriatric Depression Scale—GDS (Sheikh & Yesavage, 1986) adapted to the Spanish population by Martínez de la Iglesia, Colomer, Taberné, and Luque (2002). Five participants were excluded due to an MMSE score <24 or to dementia diagnosis according to DSM-IV (APA, 1994), and 20 participants were excluded due to suspected Mild Cognitive Impairment according to consensus criteria (Winblad et al., 2004). Twelve subjects were excluded as they had suffered mild TBI (4), stroke/TIA (7), or brain tumors (1). Finally, six participants were excluded due to suspected...
depression (GDV-VE score of 10 or greater). A decision was also agreed to exclude illiterate participants given concerns about the validity of some neuropsychological measures included in the protocol when applied to an illiterate population. In order to maximize sample homogeneity and control for potential differences in cognitive performance associated with functional hemispheric asymmetries, we included only right-handed participants.

The final sample consisted of 95 healthy older adults, 53 women and 42 men, with neither neurologic nor psychiatric disorder; no substance abuse history and without systemic diseases causing cognitive impairment. All participants gave their written informed consent. The data included in the manuscript were obtained in accordance with the regulations of the Ethics Committees of the University of La Laguna (Spain).

Participants were divided into three different groups according to their educational attainment: low, medium, and high educational levels. The low educational level group (LE) was composed of 31 participants who did not finish primary school but did learn basic reading and writing skills. In the medium educational level group (ME), there were 43 participants who finished primary school, and 21 participants who finished secondary school were included the high educational level group (HE).

As Table 1 shows that there were significant differences in terms of schooling years and the information subtest score among the educational level groups. These groups did not significantly differ in age or gender distribution.

Participants were also classified into three groups according to the total sample performance distribution in the WAIS-III information subtest (Wechsler, 1997a). Participants whose performances are in the first quartile (raw scores ≤7) were in the low information score (LI) group, while performances in the second and third quartiles were included in the medium information score (MI) group. Those participants with a performance pertaining to the fourth Quartile (raw score >15) were placed in the high information score (HI) group.

As expected, there were significant differences in terms of the information subtest scores and schooling years among information scores groups. These groups did not significantly differ in age or gender distribution (Table 2).

**Materials**

The participants’ raw scores in the Spanish version of the WAIS-III information subtest (Wechsler, 1997a) were used as measure of achievement and benefit from the schooling experience. This verbal subtest consists of 28 general knowledge questions (common facts, things, and historic characters). We administered the WAIS-III information subtest since a validated and adapted version of the WAIS-IV for Spanish population was not available at the time the present data collection was initiated. Nonetheless, the correlation between the two is high \( r = .90 \), meaning that same test characteristics apply to both versions of the information subtest (Lezak et al., 2012).

Participants completed an extensive number of neuropsychological tests administered by experienced clinical neuropsychologists over two sessions. Every session consisted of 2 h of assessment with a 20-min break. The tests were chosen to examine cognitive functioning in various cognitive domains (Table 3). Although many tests or tasks measure more than one strict cognitive function, the proposed classification refers to the main function to be measured with each selected test. Only non-standard procedures are described here.

**Reaction Times**

Choice Reaction time from the Reaction Unit/Vienna System (RT) was used (Schuhfried, 1992). Total Reaction Time is the sum of both Decision and Motor times.

**Table 1.** Demographic characteristics according to educational level

| Variable          | LE \( n = 31 \) M (SD) | ME \( n = 43 \) M (SD) | HE \( n = 21 \) M (SD) | \( F/\chi^2 \) | \( p \)
|-------------------|------------------------|------------------------|------------------------|-------------|-----
| Schooling years   | 2.47 (1.48)            | 7.21 (1.41)            | 13.43 (3.28)           | 142.044     | .0001<sup>a,b,c</sup>
| Information subtest | 8.50 (3.00)         | 10.45 (4.43)           | 18.25 (4.36)           | 37.527      | .0001<sup>a,b</sup>
| Age               | 70.55 (4.40)           | 69.00 (3.95)           | 69.86 (4.43)           | 1.240       | .294
| Gender            | 22/9                   | 21/22                  | 10/11                  | 4.261       | .119

**Notes:** Significant results in bold. LE = low educational level; ME = medium educational level; HE = high educational level; gender = women/men.

<sup>a</sup>High > low; <sup>b</sup>high > medium; <sup>c</sup>low > high.
Attention

Trail Making Test part A (Reitan, 1958) was applied to assess attention and visual tracking-visuomotor components.

Working Memory, Executive, and Pre-Motor Functions

Working memory was tested with Digit Span and Spatial Span from WMS-III (Wechsler, 1997b). Executive functions were tested with verbal fluency tasks. The verbal fluency tasks consist of asking the participants to rapidly generate words beginning by a given letter (Phonemic fluency—FAS) (Benton, Hamsher, & Sivan, 1989), to generate only animals (Semantic fluency), and to rapidly generate verbs (Action fluency; Piatt, Fields, Paolo, & Töröster, 1999). Finally, motor functioning was assessed by means of Luria’s pre-motor functions (Christensen, 1979), which includes three different components (hand-movement alternation, reciprocal coordination, and motor inhibition). The number of correct responses was recorded.

Memory

Verbal memory was tested with the Logical Memory subtest (immediate and delayed free recall and recognition of two prose passages) of the WMS-III (Wechsler, 1997b), and TAVEC (Benedet & Alejandre, 1998), the Spanish adaptation of the California Verbal Learning Test (learning with five trials of a presentation of a 16-word list, free and cued-delayed recall, and recognition) (Delis, Kramer, Kaplan, & Ober, 1987). Visual Memory was tested with the Visual Reproduction subtest from WMS-III (Wechsler, 1997b), and with a modified version of the 7/24 Spatial Recall Test (7/24 SRT), which is a spatial memory test that does not require good motor control and consists of an eight-dot pattern displayed on a 6 × 5 grid (8/30 SRT). The participants studied this arrangement for 10 s and when the pattern was removed they had to reproduce it from memory on an empty grid.
using poker chips. This learning task continued over five trials and delayed visual recall was assessed at 30 min. Visual recognition was measured with a forced choice procedure in which four grids with 10-dot patterns were presented to the participants who attempted to pick the grid with the correct pattern. This forced choice procedure was administered twice.

Visuoperceptual, Visuospatial, and Visuoconstructive

Facial Recognition Test (FRT) (Benton, Hamsher, Varney, & Spreen, 1983) and the Judgment of Line Orientation Test (Benton et al., 1983) were used to assess visuoperceptual and visuospatial functioning. Finally, the Block Design Subtest of the WAIS-III was selected (Wechsler, 1997a) for the assessment of visuoconstructive skills.

Language

We used a naming task by visual confrontation of pictorial stimuli. This task was designed by our group and consists of 40 stimuli representing elements (noun naming), and 20 stimuli depicting action scenes (action naming). Nouns and actions were paired in variables known to affect naming: every action item was paired with two noun items in word frequency (Alameda & Cuertos, 1995) and nominal agreement (Cuertos & Alija, 2003). The stimuli are line drawings of objects in black and white, taken from Cuertos, Ellis, and Alvarez (1999), the International Picture Naming Project (IPNP, 2011), and the materials of Druks and Masterson (1999). Stimuli presentation was computerized using E-Prime v1.1 (Schneider, Eschman, & Zuccolotto, 2002). Participants were instructed to name the concept represented (either the noun corresponding to the drawn element or the verb corresponding to the depicted action). Hits were recorded.

Data Analyses

Statistical analyses were performed using SPSS 17 for Windows (SPSS-S.L.). According to the previously reported highly complex relationship between cognition and schooling in aging (Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000; Van Hooren et al., 2007), we believe that treating education and information subtest scores as categorical variables instead of continuous variables might help to simplify results interpretation. This would also facilitate other researchers and clinicians when formulating new hypothesis about this relationship. Therefore, analyses of variance (ANOVA) were performed to compare groups on different neuropsychological measures. Bonferroni correction was applied when post hoc contrasts were performed in order to control the statistical error associated to multiple comparisons. Chi-square tests were used with qualitative variables. Significant differences were considered when \( p \leq .05 \). Effect Size (\( f \)) was calculated with G*Power 2 Software (Dusseldorf University; Erdfelder, Faul, & Buchner, 1996), and interpreted according to the established convention (0.1 small, 0.25 medium, and 0.40 large) (Cohen, 1992).

Results

Global Cognitive Status, Reaction Time, and Attention

As Table 4 shows that both educational level and information score had significant effects on general cognitive status as assessed with MMSE. Significant differences were found in Choice Reaction Times between educational levels but there were no significant differences between information groups. Nonetheless, when Bonferroni-corrected post hoc analyses were performed these differences were not significant anymore (see Supplementary material, online materials). Although between-groups differences were found for both variables in TMT-A, post hoc analyses showed these differences did not follow the same pattern. Regarding educational level, the HE group’s performance was significantly faster than that of the LE group, while in terms of information groups the performance of the LI participants was significantly slower than that of both the MI and HI participants.

Executive Functions

Both educational level and information score exhibited a significant effect on Digit Span performance (Table 5). The highest educational level and the highest information group showed a better performance in this test than the two other educational levels and information groups, respectively. In the Spatial Span task, significant differences between educational levels were found only in the forward condition, while significant differences between information groups were also found when attending to backward scores. The performance of the HI group was better than that of the other two lower groups in the Spatial Span tasks.
Significant between-groups differences were found for educational level and information score in every verbal fluency task (Table 5). Post hoc analyses showed that the HE level was more fluent than the LE level in FAS and Semantic fluency, and was more fluent than the ME level in FAS and Action fluency. As for information score, the performance of the HI group was also better than that of the LI group in every fluency task, but the performance was only better than that of the MI group in FAS.

No significant differences were found between educational levels when analyzing pre-motor task performance. On the contrary, significant differences appeared when information groups were compared. The HI group showed a better performance than the LI in all three pre-motor measurements, and a better performance than the MI group in Reciprocal Coordination (Table 5).
Memory and Learning

There were significant between-groups differences for both educational level and information score in every Logical Memory measure (Table 6). Nonetheless, post hoc comparison showed different results patterns. The HE group significantly differed from the other two levels in immediate recall and recognition, and only from the ME group in delayed recall. In terms of information score, all the post hoc comparisons between the three groups were significant in both free recall trials, but the HI was not significantly better than MI in the recognition trial.

No significant differences were found between educational levels in any of the TAVEC measurements (Table 6). As regards information score, the LI level showed significantly more commission errors (intrusions) than the HI group, but no other significant difference was detected.

As Table 7 shows that there were no significant differences between educational levels in any of the 8/30 SRT measurements. As for differences between information groups, the recognition performance of HI was significantly better than the LI group but no other significant differences were found.

Significant differences between educational levels were found in every Visual Reproduction measurement but in false positives in the recognition trial (Table 7). HE significantly differed from ME and LE in delayed recall and recognition, and only from LE in the immediate recall. On the other hand, information score showed a significant effect in all the Visual Reproduction measurements, where the performance of HI was a better than the other two groups. MI also showed a greater recall than LI in the immediate trial.

Visuoperceptual, Visuospatial, and Visuoconstructive Abilities

As shown in Table 8, although no significant differences were found between either educational levels or information groups in FRT, both variables showed a significant effect on performance in JLO. Post hoc comparisons showed that while HE only exhibited a better performance than LE, HI performance in JLO was better than both the MI and LI groups. The same pattern of differences was found when analyzing visual reproduction scores (Table 8). As regards Block Design, both variables showed a significant effect on the total score, but furthermore, differences between information groups were found in the percentage of participants who successfully performed the simpler items of the tasks and subsequently go on to do, at least one of the items with a more complex design. In this sense, a significantly higher proportion of participants in the HI group reached this stage (complex designs) compared with the respective percentage in LI (Table 8).

Table 6. Verbal memory

<table>
<thead>
<tr>
<th>Task</th>
<th>LE (n = 30)</th>
<th>ME (n = 39)</th>
<th>HE (n = 20)</th>
<th>F</th>
<th>p</th>
<th>Effect size f</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Logical Memory (immediate recall)</td>
<td>26.87 (8.74)</td>
<td>25.90 (9.46)</td>
<td>34.85 (8.78)</td>
<td>6.951</td>
<td>0.002</td>
<td>0.40</td>
</tr>
<tr>
<td>Logical Memory (delayed recall)</td>
<td>14.33 (7.35)</td>
<td>13.74 (7.04)</td>
<td>19.00 (6.24)</td>
<td>4.041</td>
<td>0.021</td>
<td>0.30</td>
</tr>
<tr>
<td>Logical Memory (recognition)</td>
<td>20.87 (3.16)</td>
<td>20.92 (4.49)</td>
<td>23.89 (2.64)</td>
<td>4.819</td>
<td>.010</td>
<td>0.33</td>
</tr>
<tr>
<td>TAVEC (total learning)</td>
<td>46.93 (10.32)</td>
<td>45.43 (9.72)</td>
<td>49.33 (12.56)</td>
<td>0.953</td>
<td>.389</td>
<td></td>
</tr>
<tr>
<td>TAVEC (delayed recall)</td>
<td>10.73 (3.27)</td>
<td>9.93 (2.87)</td>
<td>10.24 (3.82)</td>
<td>0.544</td>
<td>.582</td>
<td></td>
</tr>
<tr>
<td>TAVEC (recognition)</td>
<td>14.77 (1.69)</td>
<td>14.48 (1.84)</td>
<td>14.52 (1.89)</td>
<td>0.240</td>
<td>.787</td>
<td></td>
</tr>
<tr>
<td>TAVEC (intrusions)</td>
<td>4.97 (4.64)</td>
<td>5.48 (6.24)</td>
<td>3.05 (2.78)</td>
<td>0.278</td>
<td>.208</td>
<td></td>
</tr>
<tr>
<td><strong>Information group</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Logical Memory (immediate recall)</td>
<td>22.97 (7.41)</td>
<td>28.67 (9.57)</td>
<td>35.17 (8.29)</td>
<td>14.078</td>
<td>.0001</td>
<td>0.57</td>
</tr>
<tr>
<td>Logical Memory (delayed recall)</td>
<td>11.00 (4.89)</td>
<td>15.53 (7.82)</td>
<td>20.27 (5.35)</td>
<td>21.555</td>
<td>.0001</td>
<td>0.57</td>
</tr>
<tr>
<td>Logical Memory (recognition)</td>
<td>19.52 (3.30)</td>
<td>21.89 (4.21)</td>
<td>23.86 (2.51)</td>
<td>11.445</td>
<td>.0001</td>
<td>0.51</td>
</tr>
<tr>
<td>TAVEC (total learning)</td>
<td>44.56 (10.47)</td>
<td>46.31 (10.07)</td>
<td>50.19 (10.99)</td>
<td>2.133</td>
<td>.124</td>
<td></td>
</tr>
<tr>
<td>TAVEC (delayed recall)</td>
<td>9.84 (3.22)</td>
<td>10.40 (2.83)</td>
<td>11.38 (3.18)</td>
<td>0.423</td>
<td>.656</td>
<td></td>
</tr>
<tr>
<td>TAVEC (recognition)</td>
<td>14.84 (1.53)</td>
<td>14.29 (2.16)</td>
<td>14.65 (1.52)</td>
<td>0.840</td>
<td>.435</td>
<td></td>
</tr>
<tr>
<td>TAVEC (intrusions)</td>
<td>6.38 (6.93)</td>
<td>4.47 (4.43)</td>
<td>3.12 (2.37)</td>
<td>4.270</td>
<td>.030</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Notes: LE = low educational level; ME = medium educational level; HE = high educational level; LI = low information group; MI = medium information group; HI = high information group.

*aHigh > low; *bhigh > medium; *medium > low; *low > high.
As Table 9 shows that educational level had a significant effect on noun naming, while information score had a significant effect on both noun and action naming. Both the highest educational level and the highest information group performed significantly better than the other two levels/groups at noun naming. In addition, the MI group performance was also better than that of LI in this task. In the case of action naming, difference between HI and LI was found in the expected direction.

Discussion

The results show a significant effect of the educational level on the general cognitive status of the study participants. The more educated group significantly differed from the middle and lower groups in its general cognitive status. The same pattern was found
in the analysis of differences according to the information subtest score. Differences in total score on the Mini-Mental State Examination (MMSE) or similar screening tests between high and low educational levels in normal aging have been widely documented (Alley, Suthers, & Crimmins, 2007; Barnes, Tager, Satariano, & Yaffe, 2004; Bravo & Hébert, 1997; Mungas, Marshall, Weldon, Haan, & Reed, 1996; Van Dijk et al., 2008). Regarding the information score, to the best of the authors’ knowledge, there are no studies using the score on the information subtest to examine these differences. However, those using other alternatives such as literacy tests to measure educational achievement also report similar results (Barnes et al., 2004).

With regard to the educational level effect on particular cognitive functions, a significant effect was found on the following functions: on attention (TMT-A), working memory (Digit and Spatial spans) and executive functions (Verbal fluency), immediate and delayed recall of stories (Logical Memory), delayed recall of drawings (Visual Reproduction), visuospatial (JLO test) and visuoconstructive processing (Block Design), and noun naming. Most of these differences indicate a significantly higher performance of participants with a high educational level compared with the other two levels.

Information subtest scores showed a significant effect not only on all the same cognitive functions as educational level but also on additional domains such as pre-motor functions. As mentioned, most of these differences indicate a significantly higher performance in participants with the highest information scores and, in addition, cognitive performance on several measures can be classified in three levels as a function of the performance on the information subtest. However, this was not the case with educational level. Moreover, effect sizes regarding information score were consistently larger than those found between educational levels.

Thus, the results reported here suggest that the Information Subtest score as an index of achievement and benefit from the schooling experience does not only influence performance in a greater number of cognitive measures than conventional indicators of educational level, but it is also better at differentiating between levels of performance, and its effect is generally of a greater magnitude.

Although no examples were found in the literature that used the score on the information subtest to determine benefit from the schooling experience and to compare this measure with traditional indices of educational level, a few existing works support the results in this study (Barnes et al., 2004; Manly et al., 2002; 2004). Barnes and colleagues (2004) found a greater association between reading ability and cognitive functioning than between the latter and educational level. Moreover, when scores were adjusted for the participants’ reading levels, the relationship between educational level and general cognitive status, executive functioning and verbal memory was no longer significant. However, the findings from the work by Barnes and colleagues (2004) are based solely on the performance of highly educated subjects (92% had over 12 years of education), and such a small range of scores might negatively affect the detection of a significant effect of educational level as an independent variable. In this work, however, these differences are examined over a broader range of educational levels, with large differences in the number of schooling years. Thus, the superiority of the information subtest score should not be attributed to methodological limitations in the analysis of the educational level.

Manly et al. (2002, 2004, 2005) have shown that literacy level is a better predictor of cognitive performance than years of education, particularly when studying ethnically diverse cohorts. Although there are no ethnic differences among the participants in this study, our results converge with those from manly in emphasizing that conventional measures of educational level (years of education or education attainment) do not seem entirely suited to assess the educational or learning experience of older individuals. In addition, we think information could be a more suitable measure than literacy test when studying Spanish-speaking samples given the characteristics of this language (e.g., all words in Spanish can be deciphered phonetically) (Del Ser et al., 1997; Nurss et al., 1995).

### Table 9. Language

<table>
<thead>
<tr>
<th>Task</th>
<th>LE (n = 30) M (SD)</th>
<th>ME (n = 39) M (SD)</th>
<th>HE (n = 20) M (SD)</th>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Noun naming</td>
<td>36.39 (3.84)</td>
<td>35.60 (4.63)</td>
<td>38.95 (1.36)</td>
<td>23.846</td>
<td>.0001</td>
<td>.42</td>
</tr>
<tr>
<td>Action naming</td>
<td>14.84 (4.49)</td>
<td>16.45 (4.03)</td>
<td>17.65 (4.44)</td>
<td>2.796</td>
<td>.066</td>
<td>—</td>
</tr>
<tr>
<td>Information group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noun naming</td>
<td>33.23 (5.17)</td>
<td>36.13 (2.95)</td>
<td>39.04 (1.19)</td>
<td>32.400</td>
<td>.0001</td>
<td>.71</td>
</tr>
<tr>
<td>Action naming</td>
<td>14.97 (3.00)</td>
<td>15.87 (5.79)</td>
<td>18.21 (1.88)</td>
<td>12.967</td>
<td>.0001</td>
<td>.31</td>
</tr>
</tbody>
</table>

*Notes: LE = low educational level; ME = medium educational level; HE = high educational level; LI = low information group; MI = medium information group; HI = high information group.*

*High > low; *high > medium; *medium > low.*
In summary, educational experience has a significant effect on a large number of neuropsychological tests commonly used for the assessment of higher cognitive functions in aging. However, the educational experience is not only determined by years of education or educational attainment. Our results support alternative measures that better assess the individual achievement and the quality of the learning experience, as well as intellectual interest outside the formal academic environment. The information subtest score is presented here as an alternative to traditional educational level measurements, as it can better differentiate levels of execution in a wide range of neuropsychological variables in normal aging. This superiority is particularly apparent in attentional and frontal tasks.

Our findings suggest that attending to measurements such as information score instead of years of schooling or educational attainment could help to move forward the discussion about the influence of the educational experience on the relationship between age and cognition. Although our findings come exclusively from the study of Spanish participants, we believe the information subtest could also be a useful tool to assess educational achievement in other populations, especially when it is intended to study subjects coming from different educational systems, qualities, etc. (e.g., as in cross-sectional or transcultural designs). Moreover, the present findings could have important implications for the daily practice in clinical settings, since they might be indicating that years of formal schooling or educational attainment, variables universally used by neuropsychologist to interpret their patients’ performance, are not the relevant variables to take into consideration. Nonetheless, a major limitation of this study is the shared method variance of the WAIS-III information subtest with the other neuropsychological measures, which may have played a role in its stronger associations as compared with educational attainment. In addition, since a more recent version of the information subtest is already available and presumably more commonly used in clinical and research settings, further studies confirming the role of the WAIS-IV information subtest as an index of achievement and benefit from the schooling experience are desirable.

Supplementary Material

Supplementary material is available at Archives of Clinical Neuropsychology online.

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Conflict of Interest

None declared.

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References


