Using a Cognitive Plasticity Measure to Detect Mild Cognitive Impairment

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Abstract

This study compared performance in two groups of older adults, one healthy and another with mild cognitive impairment (MCI), in order to determine whether or not they exhibit plasticity and to analyze whether or not plastic and non-plastic participants differed after a delay. To measure cognitive plasticity, the Spain-Complutense Verbal Learning Test (TAVEC) was applied to a total of 113 participants over 65 who were divided into two groups: MCI (N = 51) and control (N = 62). It was concluded that healthy participants performed better, but impaired participants also demonstrated some capacity for learning and plasticity, and it was shown that these improvements were maintained after a delay. Therefore, TAVEC seems a fitting, simple procedure with which to measure cognitive plasticity, and an effective indicator of impairment.

Keywords: Plasticity; Assessment; Aging; Mild cognitive impairment

Introduction

Aging is accompanied by various losses of functional ability, both physical and cognitive, but as the life cycle perspective posits, development can take place in old age just as in any other stage of life. Specifically regarding cognition during old age, an array of studies has demonstrated the potential for learning and cognitive improvement by looking at the concept of plasticity (Baltes, 1987; Verhaeghen, 2000).

The term plasticity refers to the difference between a participant’s initial performance or ability and their task execution or performance after either a training phase or receiving help (Baltes & Willis, 1982). According to authors like Baltes (1987), Baltes and Kliegl (1992), and Baltes and Lindenberger (1988), plasticity can be understood as the utmost learning ability or potential a person can attain. It is, according to Lövden, Bäckman, Lindenberger, Schaefer, and Schmiedek (2010), an adaptive response to cognitive demands that exceed one’s cognitive resources. Cognitive plasticity (also conceptualized as learning ability) can be understood as an expression of neuronal plasticity (Baltes & Singer, 2001; Kempermann, Gast, & Gage, 2002) and is defined as the range a subject’s performance can improve on a task when following exposure to an optimization condition (Raykov, Baltes, Neher, & Sowarka, 2002).

Duff (2012) indicates that on repeated testing, improvements may occur due to natural recovery or intervention, but improvements can also occur because of prior exposure to test materials; the latter are typically referred to as practice effects. Practice effects are improvements in cognitive test performance due to repeated exposure to a test; such artificial improvement has traditionally been viewed as error (Duff, Beglinger, Moser, Schultz, & Paulsen, 2010; Duff et al., 2011; McCaffrey, Duff, & Westervelt, 2000). Smaller practice effects occur on less novel subtests, ones based on crystallized abilities. Meanwhile, larger practice effects seem to occur on more novel subtests, ones based on fluid abilities.

It is important to note the distinction between performance (a person’s present ability) and plasticity (their potential to improve performance) (Calero & Navarro, 2004). The distinction is relevant when it comes to disadvantaged groups like the elderly or people with cognitive impairment. Within the conceptual framework of plasticity during normal aging, there has been a fair amount of controversy as to whether this capacity for change and learning remains intact in cognitively impaired individuals. Suchy, Kraybill, and Franchow (2011) found that individuals who do not respond well to novel situations are at greater risk for
cognitive impairment. Likewise, recent data have suggested that practice effects may provide diagnostic and prognostic information in older adults with mild cognitive impairment (Duff et al., 2010, 2011).

Some of the earliest attempts to answer that question were made by authors such as Baltes, Dittman-Kohli, and Dixon (1984), Baltes (1987), Kliegl and Baltes (1987), and Kliegl, Smith, and Baltes (1989), who utilized a plasticity measure based on testing-the-limits and learning potential assessment procedures, which involve taking an initial, or baseline, measure (pre-test). Next, training is given, followed by a final measure of performance (post-test). The difference between pre- and post-test performance, then, represents a gain in score indicating one’s level of cognitive plasticity while carrying out the task.

Using that plasticity measure, those authors suggested that people with cognitive impairment would exhibit low or even non-existent gains, or plasticity scores, following training. They concluded that the cerebral changes produced with the onset of impairment can negatively affect plasticity, so such individuals have less plastic ability at their disposal than normal people. On another note, Baltes, Kühl, and Sowarka (1992), Baltes, Kühl, Gutzmann, and Sowarka (1995), Raykov and colleagues (2002), and Singer, Lindenberger, and Baltes (2003) emphasized how useful this measurement procedure is at detecting who is at-risk of impairment better and earlier. They argue that any notable difference in plasticity could be an early sign of impairment. There is a discrepancy between the pathological damage caused by impairment and its clinical manifestations, such that differences in plasticity could explain the early or late onset of symptoms.

Conversely, other studies have reported improvement after training is administered, which supports the hypothesis that cognitively impaired people can exhibit plasticity. Studies by authors such as Bäckman (1996), Clare and colleagues (2000), and Heun, Burkart, and Benkert (1997) suggested that creating the necessary conditions for learning (more training, longer presentation time, more repetition) can bring about significant improvement, even improvement that endures with time (Fernández-Ballesteros, Zamarrón, & Tárraga, 2005). From that premise, Calero and Navarro (2004) proposed a research strategy based on individualized analysis of every participant using the psychometric algorithm proposed by Schöttke, Bartram, and Wiedl (1993). According to the algorithm, subjects with a difference in pre- and post-test score of $\geq 1.5 SD$ over their pre-test score (significant gain) are said to have plasticity. The algorithm requires not only that scores increase across trials, but also that they increase significantly. They used this method to demonstrate that impaired individuals have the capacity for plasticity, which corroborates the findings of Fernández-Ballesteros and colleagues (2012). Furthermore, those authors concluded that the measure could be conceptualized as a mediating variable that, when it decreases, marks the transition from normal age-related alterations into cognitive impairment, and whose decline could denote the likely onset of MCI-related dementia.

In keeping with that procedure, the present study aimed to apply a cognitive plasticity measure based on the Test de Aprendizaje Verbal España-Complutense (TAVEC; Spain-Complutense Verbal Learning Test) to assess plastic ability in elderly adults. This measure is similar to Rey’s Verbal Learning Test (Rey, 1964) and the Auditory Verbal Learning Test of Learning Potential, adapted to measure plasticity. Previous research (Wiedl, Schöttke, & Calero, 2001) into testing this form of standard list learning showed that the three trials given between presentations significantly improved performance, thus demonstrating its validity as a measure of plasticity. This method has not been widely examined as a measure of cognitive plasticity, however, in geriatric samples. Therefore, using that measure, our first objective was to compare performance in one group of healthy older adults, and another with cognitive impairment. The following hypotheses were proposed: H1. Differences between groups will be apparent when scores are compared across trials; healthy people will have higher average scores. H2. An independent analysis of the impaired and unimpaired groups will show a significant rise in scores as the trials progress. H3. The trend will be for plasticity to increase over time, but the amount it increases from trial to trial will be less as the trials progress. Our second objective was to use the same measure to determine whether or not the two groups exhibit plasticity, proposing the following hypotheses: H4. There will be participants with cognitive plasticity in both groups. H5. Statistically significantly more people in the healthy group will exhibit plasticity than in the impaired group. Our third and final objective was to analyze whether or not the plastic and non-plastic groups’ scores differed on the delayed measure; the following hypothesis was made: H6. Subjects who exhibit cognitive plasticity will score significantly higher on the delayed measure.

Method

Participants

The total sample was comprised of 113 participants, all over 65 years old, who were divided into two groups: mild cognitive impairment (MCI) and control. The MCI group included 51 participants recruited from the Neurology Department at Consorcio University General Hospital in Valencia, Spain. The healthy group, meanwhile, was made up of 62 volunteers from Centers Specializing in Elderly Care (CEAM from the acronym in Spanish), also in Valencia, Spain. Centers Specializing in Elderly Care are public centers dedicated to programming for healthy elderly adults. The centers provide specialized services to
prevent the loss of quality of life, providing health maintenance programming, rehabilitation, and training, and promote cultural, leisure, quality of life, and social development.

The MCI group’s average age was 75.86 years (SD = 7.76), whereas the control group’s was 73.31 years (SD = 8.37). As for their sex, the MCI group was 19.6% women, whereas the control group was 27.4% women. Regarding civil status, in the MCI group, 51% were married, 11.8% single, and 37.3% widow or widower. Those percentages in the control group were 50%, 17.7%, and 32.3%, respectively. Regarding the level of education, in the MCI group, 13.7% never completed elementary school, 64.7% had an elementary education only, 13.7% had secondary education only, and 7.8% higher education. Those percentages in the control group were 3.2, 62.9, 21, and 12.9%, respectively. An analysis of homogeneity across the two groups in terms of these variables revealed no significant differences.

As inclusion criteria for both groups, participants had to be over 65 years and could have no impairment that interferes with their daily activities, nor depressive symptomatology. Participants in the MCI group had to exhibit subjective memory problems, which were corroborated by a reliable informant external to this research, as well as an objective memory disorder, corroborated by standardized cognitive and neuropsychological assessments. For a person to be considered impaired, the criterion used was scoring 1.5 SD below the mean (Petersen et al., 2001). In terms of exclusion criteria, meanwhile, participants with a history of serious neurological illness, a psychiatric disorder, systemic illness, history of substance abuse, or chronic use of psychoactive drugs or sedatives were excluded.

**Instruments**

Assessments were conducted individually, always by the same female psychologist, and each session lasted ~1 h. She first discussed the study’s objectives, then explained the tasks’ approximate duration and other pertinent information, and sought participants’ informed consent. Subsequently, sociodemographic data were collected, the inclusion–exclusion criteria were applied, and the neuropsychological tests comprising the assessment were administered.

**Materials**

First, the Mini-mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) was administered, or the Mini Examen Cognoscitivo (MEC) as it is known in Spanish (Lobo, Saz, & Marcos, 2002). It gives a brief, standardized analysis of cognitive state, estimating the possible existence and severity of cognitive impairment. Additionally, Yesavage’s Geriatric Depression Scale (GDS) (Yessavage et al., 1983) was used to evaluate emotional state; subjects with scores over 14 were eliminated, in this case two participants.

With regard to the neuropsychological assessment, the Digit Span and Logical Memory subtests of the Wechsler Memory Scale III were applied (Wechsler, 2004). We administered the Test de Copia y Reproducción de Memoria de Figuras Geométricas Complejas, also known as the Figura de Rey test (Copy and Reproduction of Complex Geometric Figures from Memory Test) (Rey, 1999). In addition, we administered subtests from the Test Barcelona Revisado (TBR; Revised Barcelona Test) (Peña-Casanova, 2005). The TBR is a battery of basic neuropsychological tests consisting of several subtests assessing orientation, attention, language, reading, apraxia, agnosia, memory, abstraction, and executive functions. We used the Semantic Verbal Fluency (animals: name animals for one minute) and Phonemic Verbal Fluency (letter P: say words that begin with the letter “p” for three minutes) subtests, which assess the ability to access and recall encoded lexical and semantic information. Participants’ scores on all neuropsychological measures appear in Table 1.

<table>
<thead>
<tr>
<th>Test</th>
<th>MCI</th>
<th>Control group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Memory Test-Immediate (Rey)</td>
<td>28 (37.01)</td>
<td>67.64 (34.16)</td>
<td>.001</td>
</tr>
<tr>
<td>Visual Memory Test-Delayed (Rey)</td>
<td>8.80 (20.31)</td>
<td>27.78 (31.89)</td>
<td>.001</td>
</tr>
<tr>
<td>MMSE</td>
<td>24.64 (3.35)</td>
<td>27.62 (1.98)</td>
<td>.001</td>
</tr>
<tr>
<td>Geriatric Depression Scale (Yesavage)</td>
<td>2.02 (2.61)</td>
<td>1.29 (2.13)</td>
<td>.142</td>
</tr>
<tr>
<td>Verbal fluency Semantic (animals) (TBR)</td>
<td>11.89 (4.41)</td>
<td>16.19 (4.80)</td>
<td>.001</td>
</tr>
<tr>
<td>Verbal fluency Phonemic (letter P) (TBR)</td>
<td>18.04 (8.60)</td>
<td>25.36 (8.82)</td>
<td>.001</td>
</tr>
<tr>
<td>Digit Span (WMS)</td>
<td>8.01 (2.84)</td>
<td>10.22 (2.72)</td>
<td>.001</td>
</tr>
<tr>
<td>Logical-Memory Immediate Units (WMS III)</td>
<td>8.14 (3.09)</td>
<td>10.49 (3.26)</td>
<td>.001</td>
</tr>
<tr>
<td>Logical-Memory Immediate Themes (WMS III)</td>
<td>7.64 (3.39)</td>
<td>9.93 (3.05)</td>
<td>.008</td>
</tr>
</tbody>
</table>
Finally, the participants completed the plasticity measure, the Test de Aprendizaje Verbal España-Complutense (TAVEC; Spain-Complutense Verbal Learning Test) (Benedet, & Alejandre, 1998). The TAVEC originally consisted of three word lists presented as “shopping lists”: a learning list (list A), an interference list (list B), and a recognition list (list C). List A includes 16 words (lemon, screws, shoes, etc.). This is a standard list-learning test with a delayed measure (the delayed recall test is given 20 min after List A is read).

The TAVEC was administered like other standard list-learning tests across five consecutive trials with immediate free recall. In this case, the evaluator read each subject a word list once per trial. After each trial, the participant would say all the words he or she remembered. First, to establish a baseline, an immediate free recall test was given after presenting List A for the first time; the three subsequent presentations were posed as learning; and the final presentation gave the final, or post-test, score. The difference between one’s initial and final scores captured his or her potential, or ability to improve cognitive performance across trials with three free recalls in-between. That difference represented the gain in score, which, as argued in this study, measures cognitive plasticity. That difference was later used to determine each participant’s capacity for gain in score. To do so, using the psychometric algorithm created by Schöttke and colleagues (1993) and the criterion used by Calero and Navarro (2004) to categorize respondents, participants were considered to have high plasticity if the difference between their pre- and post-test scores was ≥1 SD from pre-test (significant gain). Conversely, participants were considered to lack plasticity if their gain score fell below that mark. As Calero and Navarro (2004) indicated, that implies categorizing subjects (establishing categories along a continuous dimension utilizing cut-off points) and also setting a criterion to assess learning test scores in such a way as to limit the methodological errors that result from both the test’s ceiling and floor effects (Dwyer, 1996).

Analysis

To compare the groups’ homogeneity prior to measurement, t-tests for independent samples and \( \chi^2 \) tests were applied. To ascertain the effects of training on TAVEC scores, a repeated-measures analysis of variance was conducted, also studying simple effects and the group (control vs. MCI) \( \times \) time (5 trials) \( (2 \times 5) \) interaction. All analyses were carried out using the SPSS 19 statistical program.

Results

The repeated-measures analysis with Huynh–Feldt’s correction revealed significant main effects of time, \( F(3,50) = 183.16; p < .001; \eta^2 = 0.623 \), and group, \( F(1,111) = 69.33; p < .001; \eta^2 = 0.384 \). A significant effect of the time–group interaction was also revealed, \( F(3,50) = 17.95; p < .001; \eta^2 = 0.139 \). The simple effects analysis comparing the two groups then revealed significant differences across the five assessment times, as the results in Table 2 convey.

Next, we studied performance on the tests at the five different moments in time, analyzing the impaired and unimpaired groups separately. That analysis revealed a significant score increase in both the impaired, \( F(4,108) = 26.33; p < .001; \eta^2 = 0.494 \), and unimpaired groups of older adults, \( F(4,108) = 103.71; p < .001; \eta^2 = 0.793 \). Intraindividual differences occurred in both groups across the various presentations of the TAVEC, except between the third and fourth presentations in the impaired group, as shown in Table 3. In addition, there was a tendency for the gain in score to decrease as the trials progressed.

Now shifting our attention to the second objective, we aimed to determine whether or not the cognitively impaired group’s scores fit the psychometric algorithm proposed by Schöttke and colleagues (1993) and therefore, whether or not any subjects showed significant gains in plastic ability. As depicted in Table 4, participants in the cognitively impaired group fell into both categories (plasticity and non-plasticity).

Furthermore, significant differences were observed (\( \chi^2 = 6.246; p = .012 \)) in the percentage of plastic individuals in the impaired and unimpaired groups of elderly adults.

### Table 2. Mean and standard deviations of groups in the trials and univariate statistical comparison

<table>
<thead>
<tr>
<th>Time</th>
<th>Controls</th>
<th>MCI</th>
<th>( F )</th>
<th>( p )</th>
<th>( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.79 (1.54)</td>
<td>3.22 (1.55)</td>
<td>28.85</td>
<td>.001</td>
<td>0.206</td>
</tr>
<tr>
<td>2</td>
<td>7.84 (2.59)</td>
<td>4.96 (1.99)</td>
<td>32.44</td>
<td>.001</td>
<td>0.226</td>
</tr>
<tr>
<td>3</td>
<td>9.37 (2.88)</td>
<td>5.86 (2.51)</td>
<td>46.47</td>
<td>.001</td>
<td>0.295</td>
</tr>
<tr>
<td>4</td>
<td>10.65 (2.89)</td>
<td>6.10 (2.76)</td>
<td>71.94</td>
<td>.001</td>
<td>0.393</td>
</tr>
<tr>
<td>5</td>
<td>11.50 (2.94)</td>
<td>7.0 (3.19)</td>
<td>60.62</td>
<td>.001</td>
<td>0.353</td>
</tr>
</tbody>
</table>
Finally, we analyzed whether or not significant differences occurred as a function of plasticity on the delayed measure (a recall test 20 min after the initial TAVEC list-learning trial). Our comparison of participants with and without plasticity yielded statistically significant differences, $t(89) = 3.41; p = .001$, the plastic group having a higher mean (10.28 vs. 7.22). We also compared delayed scores within the healthy older adult group, $t(47) = 2.51, p = .015$, finding that the plastic group scored significantly higher (11.76 vs. 9.38). Impaired individuals with plasticity also scored higher than their non-plastic counterparts, $t(39) = 2.28, p = .028; 7.64 vs. 5.30$.

### Discussion

This study sought to develop a measure of cognitive plasticity based on the testing-the-limits procedure in order to compare a group of healthy older adults to one with mild cognitive impairment. Using that measure, differences were observed between groups at the different assessment times such that the healthy group always scored higher. According to the psychometric algorithm set forth by Schöttke and colleagues (1993), gains in plasticity scores were observed in both groups, but more so in the control group. Last, upon delayed recall assessment, differences were observed favoring subjects with cognitive plasticity.

The results uphold our first hypothesis, because significant differences occurred between elderly individuals with and without impairment each of the five times the TAVEC was administered, and between the two groups’ respective score increases. Thus, significant differences between the five scores, pertaining to the five TAVEC trials, were confirmed in both healthy and impaired subjects, the healthy participants having higher mean scores than the impaired participants. Along those lines, plastic ability and adaptation to external demands were clearly stronger in healthy subjects, but those impaired exhibited a certain capacity for learning, too. We also confirmed a time-group effect, upholding our hypothesis that elderly subjects’ scores would increase after receiving training. Significant differences were observed in favor of healthy subjects when plasticity assessment tasks were applied during a test phase, over the course of three trials, and in a post-test phase.

In light of the two groups’ observed score increases, in testing the second hypothesis, which proposed analyzing the two groups separately like in one study by Calero and Navarro (2004), we observed that scores always rose continuously from one trial to the next. The gains in score from trial to trial tended to get progressively smaller as the trials went on. As shown in earlier research (Duff et al., 2007; Duff, Chelune, & Dennett, 2012; Duff, Callister, Dennett, & Tometich, 2012), learning across repeated exposure to test materials is a very important element. These studies have shown that practice effects on repeated cognitive testing has prognostic value in elderly patients. Although learning is continuous, as these results convey, the profit in score is slightly less with each, successive trial. Recently, Lövdén and colleagues (2010) proposed a theoretical model according to which the term “plasticity” hinges on the capacity for change, and plasticity fits a learning curve where change in performance is rapid at first, then slows down. In other words, the model holds that the supply initially responds to growing demands, but later, once the supply has met the demands, the impulse for change is not renewed.

With regard to the second objective, we aimed to determine whether or not there were plastic and non-plastic participants within both the impaired and unimpaired groups of elderly adults. This was determined based on significant gains in TAVEC scores and the psychometric algorithm posited by Schöttke and colleagues (1993). We would like to point out that utilizing the TAVEC and immediate free recall tests across five trials was a fitting, simple procedure to measure cognitive plasticity. Using that procedure,

### Table 3. Mean difference between successive applications TAVEC in the groups with and without cognitive impairment

<table>
<thead>
<tr>
<th>TAVEC</th>
<th>MCI difference of means</th>
<th>Controls difference of means</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>$-1.745^a$</td>
<td>$-2.694^a$</td>
</tr>
<tr>
<td>2–3</td>
<td>$-0.902^a$</td>
<td>$-1.887^a$</td>
</tr>
<tr>
<td>3–4</td>
<td>$-0.235$</td>
<td>$-1.274^a$</td>
</tr>
<tr>
<td>4–5</td>
<td>$-0.902^a$</td>
<td>$-0.855^a$</td>
</tr>
</tbody>
</table>

$^a$Mean difference is significant at .05.

### Table 4. Distribution of individuals with and without deterioration in function of the presence of significant plasticity

<table>
<thead>
<tr>
<th>Group</th>
<th>Plasticity</th>
<th>No plasticity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCI</td>
<td>16</td>
<td>35</td>
<td>51</td>
</tr>
<tr>
<td>Controls</td>
<td>34</td>
<td>28</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>63</td>
<td>113</td>
</tr>
</tbody>
</table>
we confirmed an effect of plasticity and learning in the MCI group. Like the healthy group, that group benefitted from learning, significantly improving their scores. Given our cutoff of 1 SD, the rates of plasticity in both groups were unexpectedly high (e.g., 31% in MCI, 55% in controls). For example, if plasticity was a normally distributed variable, then only 16% of a sample should exceed a cutoff of 1 SD. It is possible that procedures and normative data from Schöttke and colleagues (1993) and Calero and Navarro (2004) might be less applicable to this sample. As these procedures develop, additional normative data on change across trials may be needed.

Similar to those results, several studies (Calero & Navarro, 2004; Fernández-Ballesteros, Zamarrón, Tárraga, Moya, & Íñiguez, 2003) have reported significant interaction effects between score increase on the Test de Posiciones (TP; Positions Test) and the Auditory Verbal Learning Test of Learning Potential (AVLT-LP) in cognitively impaired subjects. Like those findings, these results lead us to confirm that cognitively impaired subjects exhibit plasticity, too, that as mentioned earlier, they can develop new learning despite their impairment. Fernández-Ballesteros and colleagues (2012) reported similar results in individuals in the early stages of Alzheimer’s disease, confirming that they had a residual ability for learning and plasticity. Furthermore, considering that healthy subjects exhibited significantly better gains in score than the MCI group, this measure could be viewed as a protective factor from dementia, and a marker or indicator of cognitive decline (Calero & Galiano, 2009). In fact, an earlier study (Raykov et al., 2002) compared two assessment procedures for detecting risk of dementia, a brief neuropsychological assessment battery and a relational figures test that is part of the testing-the-limits procedure. They showed that the latter alone explained the same percentage of variability as the former, revealing its power to diagnose cognitive status. By the same token, Duff and colleagues (2010, 2011) and Duff (2012) showed that while practice effects are robust in cognitively intact older adults, there is also evidence that amnesiacs with Mild Cognitive Impairment (aMCI) also exhibit practice effects on cognitive and motor tests, even across brief test–retest periods (Duff, Beglinger, & Schultz, 2007; Duff et al., 2008).

On another note, considering how difficult it is to establish diagnostic criteria for MCI and its many sub-types due to the conceptual limitations of MCI itself, we emphasize the need to establish agreed upon criteria to guide diagnosis, as well as instruments and cut-off points to apply. As the plasticity measure set forth by Calero and Navarro (2004) has been demonstrated to effectively detect impairment, it could be integrated into neuropsychological assessment for subjects with memory problems as an additional diagnostic factor or indicator, perhaps in combination with other neuropsychological tests. Duff and colleagues (2011) proposed that clinically speaking, improvement in practice effects could allow healthcare providers to predict cognitive trajectories (e.g., worsening or improvement). In research, meanwhile, practice effects can be used as a screening tool in clinical trials to enrich aMCI samples that would not unexpectedly revert to normal in a year, or to define a subgroup of aMCI patients more likely to benefit from cognitive rehabilitation strategies. With that in mind and with an eye to future research, it would be interesting to longitudinally study the possibility that reduced plastic ability in impaired individuals could be the crucial point beyond which illness cannot revert back to health.

Moreover, this measure of plasticity not only allows one to draw diagnostic conclusions. We can also reasonably conclude that in clinical practice, if certain training exercises were carried out, it could effectively elicit new learning in this type of clinical population. Treatment can effectively improve cognitive performance by successfully increasing cognitive plasticity, just as cognitive stimulation intervention in the early stages of dimension has shown (Zamarrón, Tárraga, & Fernández-Ballesteros, 2008). These results support the notion that non-pharmacological treatments should be used in this type of patients to stimulate cognitive ability, as well as to effectively cease or slow impairment and with it, the onset of dementia (Olazarán et al., 2010).

Finally, addressing the third objective, which had to do with scores on the delayed trial of the TAVEC list-learning test, differences between the plastic and non-plastic groups were observed on this measure favoring the more plastic subjects. This confirmed not only the existence of plasticity, but also that its benefits endured with time, as Clare and colleagues (2000) and Duff and colleagues (2011) also showed. Those authors reported that improvements were maintained across follow-up measures at 3 months, 6 months, and 1 year.

In fact, consistent with the findings of Duff and colleagues (2011), these patients seemed to fall into two subtypes: those who remained cognitively stable over time and those who declined. Specifically, they illustrated that aMCI individuals who showed large practice effects at 1 week remained relatively stable after 1 year, whereas those who improved only minimally through repeated exposure to test materials at 1 week declined over time. Those authors suggested that their findings were evidence that the diagnostic criteria for MCI should be changed; they recommended including “evidence of decline over time” to improve diagnostic accuracy. This new criterion for MCI might also entail a lack of practice effects within a short period of time. Lövdén and colleagues (2010), in their theoretical model, similarly emphasized how important it is that such changes be maintained over time.

By way of conclusion, it is important to heed the importance of cognitive plasticity assessment in elderly populations, not only for its usefulness in diagnosis and early detection of mild cognitive impairment, but also as a valid tool to evaluate learning potential, and therefore subjects’ potential to rehabilitate through cognitive stimulation treatment (Zamarrón et al., 2008). Of future lines of research on neuropsychological assessment, we propose that given the TAVEC’s extensive use in assessing cognitively
impaired patients, this short, simple, standardized test, can provide produce a gains in score, thereby quantitatively estimating cognitive plasticity. That is in addition to it providing information about subjects’ short- and long-term free recall, memory where semantic information is key, learning, and recognition. However, this study had several limitations. Because both groups (control and MCI) were divided into non-plasticity and plasticity, sample size was limited. With respect to the MCI categorization, note that this diagnosis was based on neuropsychological evaluation and was not corroborated by neuroimaging. It would also have been pertinent to have carried out a follow-up evaluation to determine whether these gains would be lasting, which would have required longitudinal study. As discussed earlier, some of the cited studies reported that analyzing delayed recall measures can provide valuable information about the progression of impairment in subjects with MCI. To verify these aspects would not only be of interest from a diagnostic perspective; it could also have important implications in developing criteria to evaluate MCI. Thus, one direction for future research would be to extend the time intervals at which delayed measures are taken, compare the results with those of the present research, and take stock of the long-term cognitive progression. Finally, another limitation might be the results’ generalizability. As most participants had attained only elementary education, to generalize the results to populations with higher levels of education would be dubious.

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**Conflict of Interest**

None declared.

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