INTRODUCTION

According to Alzheimer’s Disease (AD) International, as many as 28 million of the world’s 36 million people with dementia have yet to receive a diagnosis, and therefore do not have access to treatment, information, and care (Alzheimer’s Disease International, 2011). They forecast that dementia will continue to affect the population worldwide and low-income countries will experience a more dramatic impact. A factor undermining the early diagnosis of dementia is the lack of reliable assessment methods (Sperling et al., 2011). The present study was aimed at investigating whether the combined use of neuropsychological and electrophysiological methods (i.e., P300) could help tackle this research priority. Particularly, this study investigated whether this combined approach would yield a methodology capable of achieving good classification powers (i.e., sensitivity and specificity) in populations with low socio-cultural background such as that found in Latin American countries (see Ardila et al., 1994).

Alzheimer’s disease is the most common form of dementia (Blennow et al., 2006). Although memory impairment is its most salient feature (Greene et al., 1996; Graham et al., 2004; Dudas et al., 2005; Nestor et al., 2006), the disease often presents with different neuropsychological phenotypes (Fields et al., 2011). This heterogeneity also characterizes the preclinical stages of AD [e.g., Mild Cognitive Impairment (MCI), Petersen, 2004, 2006; Petersen and Knopman, 2006; Petersen and Negash, 2008]. For example, different phenotypes of MCI have been identified and each has been associated with a different risk for AD (Dubois et al., 2007; Albert et al., 2011; Jack Jr. et al., 2011; Sperling et al., 2011). The study of individuals with MCI has shown that those who have memory impairment as a prominent feature in their cognitive profile (i.e., Amnestic MCI) have the highest probability of developing AD in the future (Bozoki et al., 2001; Lopez, 2003; Lopez et al., 2003; Petersen, 2006; Fields et al., 2011). Therefore, amnestic MCI is a preclinical form of dementia which can offer the best opportunity to investigate whether the combined use of neuropsychological tests and the P300 can aid in the early identification of changes suggestive of risk for AD. This was precisely the aim of the present study.

The presence of different biomarkers may suggest AD but do not lead to a definite diagnosis of AD (Albert et al., 2011; Jack Jr.
... et al., 2011; Spelten et al., 2011). Neuropsychological testing is crucial within this context. However, available memory tasks have not yet achieved sufficient diagnostic accuracy (i.e., combine sensitivity and specificity) as to grant them reliability in the detection of AD (Lownes and Savage, 2007; Parra et al., 2010; Didic et al., 2011). Hence, there is a need for combined assessment tools which can improve the early diagnosis of dementia (Rachakonda et al., 2004; Dickerson et al., 2007; Dubois et al., 2007; Burns and Morris, 2008; Albert et al., 2011; Jack Jr et al., 2011; Spelten et al., 2011). Event Related Potentials (ERPs), particularly the P300 wave, has proved to be sensitive to the early effects of AD (Muir et al., 1988; St Clair et al., 1988; Wright et al., 1988; Polich, 1989; Pokryszko-Dragan et al., 2003; Katada et al., 2004; Polich and Corey-Bloom, 2003; Ally et al., 2006; Bonanni et al., 2010; Lai et al., 2010). Using the classical odd-ball paradigm (Sutton et al., 1965) the characteristics of the P300 wave that have proved most useful in experimental and clinical settings are its amplitude and latency. These parameters are thought to be related to early conscious processes involved in attention and memory control (Donchin and Coles, 1988; Picton, 1992). As an index of early attentional and selection processes (i.e., a low-level cognitive function), the P300 component recorded during a classical odd-ball task does not seem to be reliant on the level of education of the assessed individual (see O’Donnell et al., 1995 for an example in schizophrenia). This makes it suitable to investigate cognitive decline in populations with low average education.

There is now sufficient evidence to suggest that the latency and amplitude of the P300 are altered in AD (Polich, 1989; Pokryszko-Dragan et al., 2003; Katada et al., 2004; Polich and Corey-Bloom, 2005; Ally et al., 2006; Muscoso et al., 2006; Caravaglios et al., 2008; Bonanni et al., 2010; Lai et al., 2010). Furthermore, evidence has been accrued suggesting that characteristics of the P300 wave are also compromised in individuals with MCI (Frodl et al., 2002; Golob et al., 2002; Bennys et al., 2007; van Deursen et al., 2009; Lai et al., 2010). Recent studies suggest that the latency and amplitude of the P300 wave might serve as a marker for monitoring the process through which MCI becomes AD (Golob et al., 2002, 2009; Papaliagkas et al., 2008; van Deursen et al., 2009). Changes in the P300 parameters have been identified in carriers of gene mutations that lead to familial AD almost 10 years before the disease onset (Golob et al., 2009). Taken together these results suggest that the P300 could contribute to the assessment of AD.

However, neither the P300 variables nor the neuropsychological tasks on their own have achieved enough specificity for a particular type of dementia such as AD (see for example Papaliagkas et al., 2008 for a report on poor correlations between P300 variables and other neuropsychological variables). More research is therefore needed to investigate whether the combined use of sensitive cognitive and biological markers can improve both the predictive and classification power of available assessment methods. Papaliagkas et al. (2010) combined the analysis of P300 with quantification of beta-amyloid (1–42) levels in Cerebrospinal Fluid (CSF). The authors reported values of sensitivity and specificity for the combination of CSF beta-amyloid levels and P300 latency of 80 and 98% respectively (100 and 89% for the P300 amplitude) in the discrimination between MCI converters and MCI stable patients. They suggested that the combination of electrophysiological and biological markers is a valid approach for the early diagnosis of AD. However, the analysis of the CSF requires an invasive procedure which can not be carried out outside health settings. Moreover, these assessment methods are not widely available in low-income countries. Computerized neuropsychological tests and portable systems for the recording of the P300 are now available. They are relatively inexpensive and can be used flexibly as to match patients’ environment (e.g., testing at home). Considering that P300 have been found to be sensitive even at very early stages of AD, this evidence warrants investigation of the subject addressed here.

Studies combining sensitive physiological and cognitive markers to investigate MCI are scarce. Only a handful of studies have used the analysis of the P300 component together with neuropsychological tests to assess MCI and AD, and risk of MCI to AD conversion (Lastra et al., 2001; Lai et al., 2010; see also Revenok et al., 2001). These studies have focused on populations with a socio-cultural background very different to our own (Ardila et al., 1994), or have assessed groups of individuals with a non-specific risk for dementia (younger age bands, cortical, and subcortical dementia, etc.). Thus, the actual value of this combined approach for the early detection of AD still requires further investigation. The present study was aimed at investigating this issue in a sample of MCI patients who are known to be at a high risk for AD and in a sample of AD patients. Our prediction was that combining the analysis of the P300 (particularly P300 Latency, see Revenok et al., 2001 and Lai et al., 2010) with standard neuropsychological tests would yield more reliable outcomes in the identification of MCI and AD (i.e., increase sensitivity). We also predicted that the combined approach investigated here would also improve the specificity of the assessment process as the reliance of the P300 paradigm used in this study on the background education is minimal hence healthy controls who have limited cognitive reserve would be better classified (see Nitini et al., 2009). We are not aware of previous studies which have addressed these issues with the methodology proposed here in the assessed population.

MATERIALS AND METHODS

The present study was reviewed and approved by the Ethics Committee of the Health Faculty at the Surcolombiana University, Colombia.

PARTICIPANTS

A sample of 30 subjects was selected from the population studied by Gooding et al. (2006) following the procedures described below. Participants within each group (i.e., Healthy Controls, MCI, and AD) were randomly identified from our database. All the participants recruited into the study underwent a general interview, a neurological, and a neuropsychological examination. A multidisciplinary team including neurologists, psychiatrists, psychologists, and neuropsychologists performed the three assessment steps. When available, neuroimaging data also entered the diagnostic process. The team confirmed the diagnosis following the criteria set by NINCDS-ADRDA Group (McKhan et al., 1984) for AD and by Petersen (2004) for MCI. To be considered for the MCI group, participants should have subjective memory complaints with memory deficits documented by at least one objective memory test (minimum 1.5 SD below the norms). They should have
no functional limitations as assessed by the Lawton Scale (see for example Morris, 2012 for recent suggestions). In addition to these criteria, participants were excluded from the study if they scored below 14 on the MMSE, had a previous history of psychiatric or neurologic disorders, were unable to consent by themselves, or presented with any kind of addiction or severe visual problems. The final sample comprised 10 patients with mild to moderate AD, 10 patients with MCI, and 10 healthy controls. All participants gave informed consent to take part in the study.

Table 1 presents the demographic and psychometric variables as well as the functional scales for the three groups, together with the result of statistical comparisons. For the comparison of these variables we used one-way ANOVA followed by Bonferroni-corrected post hoc tests. For all the comparisons alpha was set at 0.016 (three contrasts per each demographic variable).

### Table 1 | Demographic, psychometric and functional variables in the selected sample.

<table>
<thead>
<tr>
<th></th>
<th>Controls (n = 10)</th>
<th>MCI (n = 10)</th>
<th>AD (n = 10)</th>
<th>Controls vs. MCI</th>
<th>Controls vs. AD</th>
<th>MCI vs. AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>64.70 (4.24)</td>
<td>72.60 (8.11)</td>
<td>74.10 (5.72)</td>
<td>0.026</td>
<td>0.007</td>
<td>1.00</td>
</tr>
<tr>
<td>Education (years)</td>
<td>5.30 (4.03)</td>
<td>3.80 (4.39)</td>
<td>1.30 (1.83)</td>
<td>1.00</td>
<td>0.058</td>
<td>0.396</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>3/7</td>
<td>4/6</td>
<td>4/6</td>
<td>0.85*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMSE</td>
<td>27.50 (2.95)</td>
<td>26.20 (2.30)</td>
<td>20.80 (4.37)</td>
<td>1.00</td>
<td>&lt;0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>GDS</td>
<td>1.10 (0.32)</td>
<td>2.10 (0.32)</td>
<td>2.80 (0.42)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depression (Yesavage)</td>
<td>1.20 (1.14)</td>
<td>3.20 (1.81)</td>
<td>3.40 (2.41)</td>
<td>0.070</td>
<td>0.041</td>
<td>1.00</td>
</tr>
<tr>
<td>IADL (Lawton)</td>
<td>8.00 (0.00)</td>
<td>9.40 (2.88)</td>
<td>12.00 (4.90)*</td>
<td>1.00</td>
<td>0.033</td>
<td>0.236</td>
</tr>
</tbody>
</table>

GDS, Global Deterioration Scale; IADL, Instrumental Activities of Daily Living; MMSE, Mini-Mental State Examination. Post hoc contrasts were significant at p < 0.016 (Bonferroni-corrected). *Chi-square revealed no significant differences in the sex by group distribution.

### Results

#### Neuropsychology

The results of the analysis of the neuropsychological data are shown in Table 2. Patients with MCI presented lower performance...
Table 2 | Performance of the three groups on the neuropsychological battery and results of the statistical analysis.

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>MCI</th>
<th>AD</th>
<th>Kruskal–Wallis</th>
<th>Adjusted pairwise contrasts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td>p-value</td>
</tr>
<tr>
<td>TMT (time s)</td>
<td>159.0 (60.01)</td>
<td>205.10 (93.54)</td>
<td>423.60 (172.48)</td>
<td>0.001 ns/0.5/23</td>
<td>0.001/2.0/99</td>
</tr>
<tr>
<td>TMT (hits)</td>
<td>23.90 (0.32)</td>
<td>22.70 (2.50)</td>
<td>12.00 (3.02)</td>
<td>0.001 ns/0.7/29</td>
<td>0.001/1.5/81</td>
</tr>
<tr>
<td>WCST (conceptualization)</td>
<td>11.60 (11.02)</td>
<td>16.90 (13.14)</td>
<td>15.70 (17.42)</td>
<td>0.318</td>
<td>0.031/1.6/92</td>
</tr>
<tr>
<td>WCST (categories)</td>
<td>2.50 (5.42)</td>
<td>13.45 (7.45)</td>
<td>4.65 (4.26)</td>
<td>0.008</td>
<td>0.05/0.20</td>
</tr>
<tr>
<td>WCST (hits)</td>
<td>19.80 (10.63)</td>
<td>14.40 (4.97)</td>
<td>13.20 (7.79)</td>
<td>0.211</td>
<td>0.06/0.71</td>
</tr>
<tr>
<td>Memory for 3 phrases</td>
<td>2.70 (0.48)</td>
<td>2.30 (0.82)</td>
<td>2.30 (0.82)</td>
<td>0.437</td>
<td></td>
</tr>
<tr>
<td>World list (immediate)</td>
<td>19.50 (3.21)</td>
<td>14.80 (2.66)</td>
<td>12.00 (4.83)</td>
<td>0.001</td>
<td>0.031/1.6/92</td>
</tr>
<tr>
<td>World list (delayed)</td>
<td>7.10 (2.08)</td>
<td>5.10 (1.10)</td>
<td>2.70 (2.67)</td>
<td>0.003</td>
<td>0.12/70</td>
</tr>
<tr>
<td>World list (recognition)</td>
<td>19.40 (1.07)</td>
<td>19.00 (1.33)</td>
<td>17.00 (3.09)</td>
<td>0.066</td>
<td></td>
</tr>
<tr>
<td>Verbal fluency (animals)</td>
<td>19.60 (3.86)</td>
<td>15.20 (3.36)</td>
<td>11.50 (3.92)</td>
<td>0.000</td>
<td>0.03/11</td>
</tr>
<tr>
<td>Boston naming test</td>
<td>13.30 (1.77)</td>
<td>12.10 (1.60)</td>
<td>10.30 (1.57)</td>
<td>0.005</td>
<td>0.07/32</td>
</tr>
<tr>
<td>Rey figure (copy)</td>
<td>23.75 (9.76)</td>
<td>27.60 (7.75)</td>
<td>12.45 (6.55)</td>
<td>0.004</td>
<td>0.04/15</td>
</tr>
<tr>
<td>Rey figure (recall)</td>
<td>10.00 (5.42)</td>
<td>13.45 (7.45)</td>
<td>4.65 (4.26)</td>
<td>0.008</td>
<td>0.5/20</td>
</tr>
<tr>
<td>WCST (short)</td>
<td>19.80 (10.63)</td>
<td>14.40 (4.97)</td>
<td>13.20 (7.79)</td>
<td>0.211</td>
<td>0.06/0.71</td>
</tr>
<tr>
<td>WCST (categories)</td>
<td>2.50 (1.72)</td>
<td>1.30 (0.67)</td>
<td>1.10 (9.83)</td>
<td>0.023</td>
<td>0.08/0.71</td>
</tr>
</tbody>
</table>

Adjusted pairwise contrasts were carried out when the main effect of group was found to be significant:

Letter A cancelation (Hits = number of letters correctly cancelled out of 16); TMT, Trial Making Test (Hits = number of circles correctly connected out of 25); WCST, Wisconsin Card Sorting Test (Hits = number of cards correctly classified out of 48, Short-version; Conceptualization = number of trials to first category); p-value/β = statistical significance/effect size (Cohen d)/Power (%).
the four measures and also calculated the sensitivity and specificity for each of them.

As Figure 2 and Table 3 show, the latency of the P300 combined more sensitivity and specificity for MCI and AD than the other two memory tasks that also proved sensitive in this analysis and in previous ANCOVA. In fact, the latency of the P300 component proved to be the most sensitive measure. When the sensitivity and specificity were calculated based on the values of both the latency of the P300 and memory for word lists (combined sensitivity and specificity) using a series testing approach (which considers that both tests must be positive in order to prompt action, see Schoenbach and Rosamond, 2001), the sensitivity values for MCI increased considerably (96%) whereas the specificity remained high (80%). Of note a cut-off score > 441.5 ms for the Latency of P300 resulted in a sensitivity of 100% and a specificity of 80% for MCI. This suggests that the combined use of neuropsychological and electrophysiological functions can offer better solutions for the detection of cognitive changes associated to MCI and AD.

### ADDITIONAL ANALYSIS

Finally, although this was not conceived as a longitudinal study, we approached our participants to reassess their neuropsychological functions. The initial assessment was concluded in 2005. From September 2011 to March 2012 (between 5 and 6 years after the first assessment) we were able to contact and reassess four patients initially seen as MCI and three healthy controls. Two of the initial MCI patients died in this interval, two had changed residence, one did not consent to take part in the reassessment, and one could not be contacted. Of the controls, one died, one did not consent to participate in the reassessment, and the others could not be contacted. We thought that although this dataset is limited it could still be informative. These subjects were reassessed using the same neuropsychological protocol and the criteria for MCI (Petersen, 2004) and AD (McKhann et al., 1984) were applied. Of the four MCI patients reassessed, two had converted to AD, one returned to normality, and one had an uncertain diagnosis. The patient with an uncertain diagnosis showed clear improvement in her global cognitive functions and other neuropsychological functions such as memory, attention, and executive function. However, her score on the IADL scale (Lawton) dropped relative to the first assessment. None of the healthy controls reassessed met MCI or AD criteria. The P300 data and the neuropsychological scores corresponding to the reassessed participants can be found in Table A1 in Appendix. The two MCI patients who converted to AD showed the longest latencies of the P300 component relative to the other reassessed participants. Of note, the MCI patient who returned to normality and the patient who received an uncertain diagnosis during the reassessment showed P300 latencies in the initial assessment which were within the normal limits.

### DISCUSSION

The present study was set out to investigate whether the combined analysis of neuropsychological variables and variables of the P300 wave would yield classification powers (i.e., sensitivity and specificity) during the assessment of patients with MCI and AD better than those reported with each methodology separately. This hypothesis was investigated in a population with low socio-cultural background which is known to pose challenges to the interpretation of the outcomes of standard neuropsychological tasks (see Ardila et al., 1994). Three variables were found to achieve sensitivity and specificity values above 80% (Immediate and Delayed recall or word list – CERAD – and the latency of P300) for both MCI and AD. When they enter the model together (i.e., combined approach) the sensitivity for MCI increased to 96%
FIGURE 2 | Results from the ROC analysis carried out with neuropsychological and physiological variables that were found to be significant in group comparisons.

Table 3 | Results of the ROC analysis with the variables which resulted in significant differences in group comparisons.

<table>
<thead>
<tr>
<th>Cut-off</th>
<th>AUC</th>
<th>SE</th>
<th>CI 95%</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word list (immediate) ≤ 17</td>
<td>0.88</td>
<td>0.08</td>
<td>0.65–0.98</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Word list (delayed) ≤ 5</td>
<td>0.78</td>
<td>0.12</td>
<td>0.54–0.93</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Lat P300 FZ &gt; 465.5</td>
<td>0.97</td>
<td>0.03</td>
<td>0.78–1.00</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Amp P300 FZ ≤ 4.4</td>
<td>0.84</td>
<td>0.09</td>
<td>0.60–0.96</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

and the specificity remained high (80%). These results lend support to our hypotheses. We now discuss the implications that these findings have for the assessment of MCI and AD.

The literature on AD and MCI reporting on the combined use of neuropsychological and psychophysiological tests is scarce. Lasstra et al. (2001) reported findings similar to our own (see also Lai et al., 2010). These authors concluded that the latency of P300 is a useful tool in the early diagnosis of AD. This suggestion was supported by the observation of individuals with prolonged P300 latencies, who despite scoring 30 points on the MMSE, later developed AD. Recent findings of abnormal P300 parameters (i.e., long latencies and small amplitudes) in asymptomatic carriers of a gene mutation which leads to familial AD (Golob et al., 2009) almost 10 years before the disease onset support the validity of this test as a preclinical psychophysiological marker for AD. Neuropsychological tests and P300 variables have been used in combination for the evaluation of the therapeutic response to anticholinesterase drugs in patients with AD (Werber et al., 2001, 2003; Onofrj et al., 2002; Katada et al., 2003; Paci et al., 2006). However, the evidence provided by these earlier studies comes from rather heterogeneous (i.e., wide age ranges, different forms of dementia) and non-representative samples (e.g., with a level of education much higher than that observed in Latin American countries). The present study focused on a relatively small but more homogenous sample of amnestic MCI patients whose age was closer to that known to be associated with late-onset sporadic AD and whose education truly reflects the level reached by individuals of this age band in Latin American countries. This evidence is lacking in the literature concerning early detection of AD (Doraiswamy et al., 1995; Hong et al., 2011; see also Ardila et al., 1994).

One other study which is relevant to this discussion is one carried out by Lai et al. (2010). They also investigated the value of combining the study of the P300 with neuropsychological variables in patients with AD and MCI. They reported results similar to ours in a relatively larger group of patients. It is worth noting that the average education of their patients was 7.15 (5.03) and 9.89 (5.15) for AD and MCI respectively. This is much higher that the average education of our patients. However, the outcomes from both studies are similar. It is known that performance on traditional neuropsychological tests is highly sensitive to the subject’s educational level. For example in the present study the average MMSE value for the controls was 27.5. Other studies have observed
AD and MCI appears to be feasible. Nevertheless, the diagnosis of MCI in this study, the results were statistically significant and suggest that the combined analysis of the P300 and memory for word lists considerably boosted the sensitivity of detection methods for neurodegenerative dementias in general and AD in particular (Rachakonda et al., 2004). While the combined analysis of the latency of the P300 and memory for word lists considerably boosted the sensitivity of the assessment method, it did not impact to the same extent on the specificity which, although high (80%), was kept at the level of the neuropsychological variable. The combined use of measures from different levels (neuropsychology and neurophysiology) implies a more adequate integrated approach to AD and MCI research (Kuljis, 2009). For example, clinicians could focus on the combined approach for detection (i.e., sensitivity) and give more weight to the P300 latency in the separation of healthy from pathological aging (i.e., specificity).

Moreover, although high density arrays are currently available, we chose for this study only two recording sites (i.e., Pz and Fz). These have been suggested as the locations where the P300 component shows its optimal parameters (i.e., latency and amplitude; Osawa, 2001). This very simple, easy to apply, and inexpensive method proved sufficient and would allow adequate recording and later comparison with other neuropsychological variables in any clinical research settings. Finally, we have identified significant P300 changes and poor memory performance in a small group of MCI patients who, according to their profile, presented with the amnestic form of cognitive impairment. This is known to be the form of MCI that most commonly leads to AD (Bozoki et al., 2001; Lopez, 2003; Lopez et al., 2003; Fields et al., 2011). However, it is known that not all MCI patients will eventually convert to AD (Lonie et al., 2010). Although the P300 parameters deteriorate as AD progresses (Ball et al., 1989), this component has not been extensively used to monitor longitudinally MCI or AD patients. Therefore, future studies should address whether the combined approach proposed here could help predict MCI to AD conversion thus permitting its use as a cognitive/functional biomarker for AD.

CONCLUSION
We have combined the analysis of the P300 and standard neuropsychological variables to assess a sample of patients with MCI and AD taken from a Latin American population which has a sociodemographic structure typical of low-income countries and which had not been assessed before using this methodological approach. We have found that this combined approach can provide valuable information for the detection and evaluation of patients with MCI and AD. Our preliminary findings suggest that in populations with low socioeconomic and educational levels, the combined use of these techniques may offer a very useful method for the preclinical assessment of AD. Our results provide a platform and
justification to employ more resources to convert P300 and related parameters into an accepted biological marker for AD. This would allow the definition of cut-off values which can help in the distinction between normal and pathological aging (e.g., indicators of neurodegeneration). Moreover, these norms would permit an easy, inexpensive, and objective diagnosis as well as longitudinal assessment of larger samples of MCI patients.

REFERENCES


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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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**APPENDIX**

Table A1 | The table shows the data corresponding to the seven reassessed participants.

<table>
<thead>
<tr>
<th>Initials</th>
<th>Initial status</th>
<th>Current status</th>
<th>Lat P3-Fz</th>
<th>Amp P3-Fz</th>
<th>Lat P3-Pz</th>
<th>Amp P3-Pz</th>
<th>Global cognition</th>
<th>MMSE</th>
<th>Word list (immediate recall)</th>
<th>Word list (delayed recall)</th>
<th>Rey figure (recall)</th>
<th>Attention</th>
<th>Fluency</th>
<th>Daily life activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAM</td>
<td>MCI Converted to AD</td>
<td>564.47</td>
<td>3.24</td>
<td>558.47</td>
<td>3.17</td>
<td>10% Drop</td>
<td>13.00</td>
<td>4.00</td>
<td>0.00</td>
<td>198.00</td>
<td>14.00</td>
<td>43% Drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAP</td>
<td>MCI Converted to AD</td>
<td>616.94</td>
<td>4.56</td>
<td>600.45</td>
<td>6.40</td>
<td>20% Drop</td>
<td>6.00</td>
<td>3.00</td>
<td>0.00</td>
<td>*</td>
<td>7.00</td>
<td>43% Drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCG</td>
<td>MCI Returned to normal</td>
<td>416.04</td>
<td>9.27</td>
<td>437.04</td>
<td>10.05</td>
<td>29% Increase</td>
<td>20.00</td>
<td>10.00</td>
<td>11.50</td>
<td>96.00</td>
<td>13.00</td>
<td>25% Increase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPT</td>
<td>MCI Uncertain</td>
<td>435.53</td>
<td>4.19</td>
<td>441.53</td>
<td>4.61</td>
<td>30% Increase</td>
<td>18.00</td>
<td>8.00</td>
<td>11.00</td>
<td>98.00</td>
<td>19.00</td>
<td>43% Drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFR</td>
<td>Control Continue healthy</td>
<td>441.53</td>
<td>5.53</td>
<td>447.53</td>
<td>9.25</td>
<td>3% Increase</td>
<td>13.00</td>
<td>6.00</td>
<td>11.00</td>
<td>151.00</td>
<td>13.00</td>
<td>No change</td>
<td></td>
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<tr>
<td>OTS</td>
<td>Control Continue healthy</td>
<td>435.53</td>
<td>3.14</td>
<td>464.02</td>
<td>5.37</td>
<td>6% Increase</td>
<td>18.00</td>
<td>6.00</td>
<td>3.00</td>
<td>149.00</td>
<td>13.00</td>
<td>No change</td>
<td></td>
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</tr>
<tr>
<td>MRC</td>
<td>Control Continue healthy</td>
<td>465.52</td>
<td>7.79</td>
<td>488.00</td>
<td>5.03</td>
<td>3% Increase</td>
<td>15.00</td>
<td>5.00</td>
<td>11.00</td>
<td>93.00</td>
<td>20.00</td>
<td>No change</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Could not complete the assessment; Cut-off values: were obtained from the norms corresponding to the same population (Ardila et al., 1994, 2000); Lawton: Scale of Instrumental Activities of Daily Living (IADL). The P300 variables collected during the first assessment and the Neuropsychological variables collected during the second assessment are presented. In order to assist in the clinical decision, the neuropsychological data from the first and second assessment were contrasted. Scores such as the MMSE and the Lawton Instrumental Activities of Daily Living are expressed as percentage of change in the second relative to the first assessment.