# Structure of Enhanced Cued Recall Task in the 7 Minute Screen Test

Sara Mora-Simon, Valentina Ladera-Fernandez, Ricardo Garcia-Garcia, María C. Patino-Alonso, M. Victoria Perea-Bartolome, Jaime Unzueta-Arce, Diana Perez-Arechaederra & Emiliano Rodriguez-Sanchez

Published online: 04 Apr 2016.

Submit your article to this journal ↗

Article views: 227

View related articles ↗

View Crossmark data ↗

Routledge
Taylor & Francis Group

# Structure of Enhanced Cued Recall Task in the 7 Minute Screen Test

Sara Mora-Simon[a,b], Valentina Ladera-Fernandez[a], Ricardo Garcia-Garcia[a], María C. Patino-Alonso[b,c], M. Victoria Perea-Bartolome[a], Jaime Unzueta-Arce[a], Diana Perez-Arechaederra[b] and Emiliano Rodriguez-Sanchez[b,d]

[a]Department of Basic Psychology, Psychobiology and Behavioral Sciences Methodology, Faculty of Psychology, University of Salamanca, Salamanca, Spain; [b]Primary Care Research Unit, The Alamedilla Health Center, Health Service-SACYL, REDIAPP, IBSAL, Salamanca, Spain; [c]Department of Statistics, Faculty of Medicine, University of Salamanca, Salamanca, Spain; [d]Medicine Department, University of Salamanca, Salamanca, Spain

## ABSTRACT

Episodic memory in the 7 Minute Screen is assessed by the Enhanced Cued Recall (ECR) test. The ECR test is composed of three phases, *Identification, Immediate Recall*, and *Free and Cued Recall*. However, just the last phase is considered for the total score. We believe that collecting the performance data of the Identification and Immediate Recall phases could provide information regarding possible difficulties or impairments in the different aspects involved in the temporal mnesic process of acquisition of new information, such as in working memory or visual identification. The objective was to assess the goodness of fit for the three phases of the ECR test using a Confirmatory Factor Analysis (CFA) to show if each phase is separated from each other as a different aspect that participates in the mnesic process. A total of 311 participants greater than 65 years were included in this study. Confirmatory factor analyses were conducted for each individual phase. The analyses show that the ECR test consists of three separate phases that identify different steps of the mnesic process. Individual scores for each phase could allow for investigation of patient performance in different aspects of the memory process and could help in further neuropsychological assessment.

## Introduction

Throughout recent years, research concerning the early detection of cognitive impairment symptoms has increased and new diagnostic criteria have been proposed (Albert et al., 2011). According to these recent criteria, mild cognitive impairment is the syndrome referring the presence of impairment in one or more cognitive domains (memory, executive function, attention, language, and visuospatial skills); a concern regarding a change in cognition; preservation of functionality and instrumental activities of daily living; and no presence of dementia. Dementia would be diagnosed when objective tests show that cognitive impairment is so severe that interferes not only on instrumental activities of daily living but on basics and social/work activities (McKhann et al., 2011). In order to develop a subsequent complete clinical diagnosis assessment and, then initiate an adequate treatment for the patient, many screening tests have been developed to early detect cognitive impairments (Mora-Simon et al., 2012). Some examples of these tests are the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) or the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) that screen the cognitive domains to obtain a general analysis of the cognitive status. Sometimes the effect of aging is not well distinguished from the early cognitive impairment, as many studies developed to prove the capacity of detection of these tests are cross-sectional studies. However, some few prospective studies have been developed and proved that some cognitive screening tests, such as MoCA, are good indicators of cognitive impairment (Freitas, Simoes, Alves, & Santana, 2013; Meguro et al., 2001). These tests are characterized by being quick and easy to apply and interpret, and usually allow for identifying a suspected impairment in any superior cognitive function (Carnero-Pardo, 2013). However they are usually influenced by sociodemographic variables that should be taken into account during administration of the test (Freitas, Simoes, Alves, & Santana, 2012).

One of the best known screening tests is the 7 Minute Screen (7MS) Test (Solomon et al., 1998; Solomon & Pendlebury, 1998). The 7MS was designed to detect Alzheimer's disease. It is formed by four

tests: the Benton Temporal Orientation Test (Benton, 1983), Enhanced Cued Recall (ECR) (Grober, Buschke, Crystal, Bang, & Dresner, 1988), Clock Drawing test (Freedman et al., 1994), and Categorical Fluency. These four tests assess episodic memory, verbal fluency, visuospatial and visuoconstruction abilities, and temporal orientation, which are cognitive functions that are usually impaired in Alzheimer's disease. It has been shown that the 7MS demonstrates good precision in discriminating not only patients with Alzheimer's disease from those with cognitive impairment associated with age (Solomon et al., 1998) but also in discriminating between different types of dementia (Meulen et al., 2004). However, the 7MS seems to not show a good specificity in the detection of mild cognitive impairment (MCI) (Drake et al., 2003) or psychiatric disorders, such as depression (Meulen et al., 2004).

One of the main concerns when detecting cognitive impairment is the assessment of the memory function. To do so, the 7MS includes a short version of the ECR test (Grober et al., 1988). This test assesses episodic memory by the free and cued recall of 16 drawings based on the association of these drawings with semantic clues. This short version only includes one trial of recall, compared to the three included in the original test, but it seems as effective in identifying Alzheimer's disease as the original version (Solomon et al., 1998). The ECR entails presenting four cards with four black and white drawings in each one. During the first phase (Identification), a card is presented and the examiner asks for the name of the item depicted after giving a semantic clue (e.g., Examiner: "There is a fruit on the card, what is it?" Subject: "Grapes."). During the second phase of the test, the examiner asks for the immediate recall of the drawings previously presented by giving only the semantic clue. If, in this phase, the subject fails in the immediate recall of at least one item, the entire identification procedure (Phase 1) for that card is repeated. The last phase is carried out after a distraction task (reciting the months of the year backward), and it consists of the free recall of the items previously presented. When the subject is unable to recall any additional items, then cued recall (using the original semantic cues) is repeated for those items that were not freely recalled. The highest possible score for the test is 16 points and it is obtained by summing the number of items freely recalled plus the number of items named during cued recall.

Memory consists of multiple systems and processes associated to different brain regions (Cabeza & Moscovitch, 2013). According to this, ECR task shows different processes involved in acquiring and retrieving new information. In the first phase of Identification, the subject has to perform a visual search and then identify some items associated with a given semantic clue to complete this study phase. Therefore, it requires the subject to engage in deep semantic processing. This first phase depends on some cognitive processes such as attention, perception, semantic analysis, lexical and permanent knowledge access and visual recognition (Buschke, 1987). The second phase (Immediate Recall) assesses the consolidation of item codification. In this phase, a correct initial encoding is confirmed and retrieval of the items using the clues is practiced (Grober et al., 1988). The third phase, Free and Cued Recall Phase, assesses the long-term storage of presented drawings. Healthy subjects can make use of the mnemonic strategies to store and recover the semantic clues that were associated with each item in the previous section (Solomon et al., 1998). Therefore, these three phases reflect the different processing components that are involved in a visual stimulus being identified, encoded, stored, and later retrieved (Buschke, 1987). Analyzing the performance on each phase could clinically reflect that other cognitive deficit different from memory is involved, as visual agnosia, working memory or language deficits.

Confirmatory factor analysis (CFA) is a multivariate statistical method to test whether a proposed factorial model fits the sample data. It can be used to distinguish whether one or more than one latent factors underlie a clinical concept (Kline, 2005), in this case three different factors, corresponding with each ECR phase (Identification, Immediate Recall, and Free and Cued Recall). Based on theoretical approaches, *a priori* factor model can be suggested to evaluate its fit to the data using a CFA (Miyake et al., 2000). CFA has been applied to study the structure of certain neuropsychological tests (Ecklund-Johnson, Miller, & Sweet, 2004); however, it has never been used with the ECR task to study the underlying structure of the different processes involved.

The fact that the total score was based on the sum of items from the last phase made us question the importance of the previous phases, and considering them could clinically help in detecting difficulties in the different processes that contribute to correctly learn and retrieval new information. Our objective is to assess the goodness of fit for the three phases of the ECR test using a Confirmatory Factor Analysis (CFA) to show if each phase is separated from each other as a different aspect that participate in the mnesic process. Secondly, we would like to test if there is some age and educational level effect on the phases.

## Methods

### Study design

The initial sample for this study was taken from the DERIVA (Dementia and cardioVAscular RIsk) study and it has already been published elsewhere (Rodriguez-Sanchez et al., 2011). The main objective of the DERIVA study was to explore the needs for services that promote personal autonomy and care for people older than 65 years and study the relationship between cognitive impairment and cardiovascular risk factors in people aged older than 65 years in an urban sample. This study was a cross-sectional population study that was carried out via home interviews in the urban area of Salamanca, Spain. The study was approved by an independent ethics committee of Salamanca University Hospital (Spain), and all participants provided written informed consent according to the recommendations of the Declaration of Helsinki.

### Participants

In the DERIVA study, the sample was composed of 327 subjects that were representative of the population aged older than 65 years in the city of Salamanca (Spain). We performed a stratified random sampling by health districts. Data were taken from the Castilla y León Regional Health Service lists. A letter explaining the purpose of the study and requesting cooperation was sent to selected individuals. Inclusion criteria were that each participant was aged over 65 as of January 1, 2009 and lived in the city of Salamanca (urban setting). Exclusion criteria were as follows: (a) deceased individuals, (b) errors in address, (c) people who had moved out of the study area, and (d) individuals who declined to participate in the study.

In total, 16 participants did not have a complete cognitive assessment; therefore, 311 participants were included in this study.

### Measures

1. *Sociodemographic data:* including age, gender, educational level, number of children alive, and cohabitation characteristics.
2. *Mini Mental State Examination (MMSE).* Spanish validation (Lobo et al., 1999). As in the original instrument, the Spanish version of the MMSE assesses certain cognitive domains, such as orientation, attention, concentration, memory, language, and constructional abilities (Sabe, Jason, Juejati, Leiguarda, & Starkstein, 1993). The total possible score ranges from 0 to 30 points.
3. *The 7 Minute Screen test* (Solomon et al., 1998; Solomon & Pendlebury, 1998) is composed of four tests:
   3.1. Benton Temporal Orientation Test. This test (Benton, 1983) assesses the capacity of temporal orientation of the patient. It asks about the year, day, month, day of the week, and time of day. The punctuation obtained in each item is subtracted from 113. The total highest score possible is 113 points, and 0 is the maximum error.
   3.2. Enhanced Cued Recall (ECR) test. This test (Grober et al., 1988) assesses episodic memory by evaluating individuals' capacity to learn to identify some drawings associated with semantic clues. The material of this test is composed by four cards (11.69 × 8.27 inch). In each card, four items are presented pictorially, one picture in each quadrant. The pictures are black and white drawings (Solomon & Pendlebury, 1998). The total 16 pictures are distributed in the cards as follows: Card 1, *grapes, tiger, foot and desk*; Card 2, *screwdriver, shoe, guitar and motorcycle*; Card 3, *top, tomato, spider and pot*; Card 4, *sailboat, door, eagle and cannon.* There are no distractors in the cards or between their presentations. The original scoring of this test involves summing the items that have been recalled during the free and cued recall portion of the test. Specifically, patient is asked to freely recall the items previously presented. When the subject is unable to recall any additional items, then cued recall (using the original semantic cues) is repeated for those items that were not freely recalled. One point is given for each correct free or cued recalled item retrieved by the participant. The highest possible score for the test is 16 points and it is obtained by summing the number of items freely recalled plus the number of items named during cued recall. To carry out the analysis of independence of each phase for this test, a register table of each section was added. In the first phase, whether the patient identified or did not identify each item was recorded. In the second phase, whether the patient immediately recalled or did not recall each item was recorded. In the third phase, the items that were freely and cued recalled were recorded (as in the original scoring test). Scores on each section were later summed. The highest score for each phase was 16 points, with a total possible score of 48 after the modification was made. Although the name of the 16 items is the same in all three sections, we maintain that they are not assessing the same aspect but rather individuals' separate capacities for identification, immediate recall, and free and cued recall; and as there is a temporal component, each phase is not considered as a dimension.
   3.3. Clock Drawing Test. In this test (Freedman et al., 1994), patients draw a clock with all the numbers and place the hands at the time "ten past eleven." The total highest possible score is 7 points. In this test, visuospatial and visuoconstruction abilities are assessed.
   3.4. Category Fluency. This task assesses verbal fluency, which entails the subject naming as many animals as possible in 60 seconds.

## Procedure

Participants were assessed at their home in one session lasting 30–45 minutes. After signing the consent form, sociodemographic data were obtained. Afterward, the MMSE - Spanish version, Benton Temporal Orientation Test, Enhanced Cued Recall (ECR) short form, Clock Drawing test, and Category Fluency were administered.

## Data analysis

Continuous variables were expressed as mean ± standard deviation.

To analyze the independence of each phase, three Confirmatory Factor Analyses (CFA) with discrete variables were performed. The tetrachoric correlation matrix that corresponds to the observed variables in a dichotomous scale was calculated. To estimate the tetrachoric correlation matrix, Tetcorr program (Fleming, 2005) was used. CFA were conducted using this matrix and they were executed to determine whether a model, in which each variable was allowed to be loaded, the data fit well (Siedlecki, Honig, & Stern, 2008). In addition to considering the theoretical approach of ECR, three different aspects have been taken into consideration in the CFA analysis. First, the temporal perspective indicates that this kind of tests is vertical, which means that the first phase needs to be completed to perform the second phase. The same occurs with phases 2 and 3. They are assessing different and independent information involved in the visual memory process. Second, the characteristic of the stimuli presented in this test is visual. The cerebral functional systems involved to process the information in each phase are different from those involved when the information is verbally presented, for instance. Third, two different kinds of recall are used in the ECR test, meaning two different types of access to memory. Taking all this into account, we consider that ECR is a test formed by three independent but necessary phases and the resulting factors can be orthogonal. As a result, we used oblique rotation (promax) to make a CFA for each phase, assuming each phase as a unique model.

To evaluate the goodness of fit of each model, we used the chi square statistic to evaluate the fit between the hypothesized statistical model and the actual data set. Likewise, we estimated the minimum discrepancy index (CMIN); the minimum discrepancy divided by degrees of freedom (CMIN/df); the following absolute fit indices: goodness of fit index (GFI), root mean square error of approximation (RMSEA), and root mean square residual (RMR); the following relative fit indices: comparative fit index (CFI), incremental index of fit (IFI), and normed fit index (NFI); and an information-theoretic measure of fit: Akaike's information criterion (AIC).

A model is conceptualized as having a good fit if the CMIN/df ratio is less than 4.00 with a lower index (that will indicate a better fit); the values of the GFI, CFI, NFI, and IFI are above 0.90 (a higher value indicates a better fit) and the values of the RMR and RMSEA are below 0.05. AIC is a relative fit indicator; in the absence of other substantive criteria, the best model is the one with a lower AIC (Kline, 2005).

Likewise, Cronbach's alpha was calculated for each individual phase as well as for the global test. And inter-correlations among the three phases were conducted.

To test if there is some effect of age and educational level on the subtests of the 7MS, we performed correlations and coefficients of determination.

Analyses were conducted using the IBM SPSS v.20 software; CFA were conducted using the AMOS 20, a companion to SPSS, specifically designed for performing structural equation modeling. A value of $p < 0.05$ was considered statistically significant.

## Results

### Sociodemographic data and neuropsychological outcomes

Sociodemographic data of the final studied sample are presented in Table 1. As it can be seen, mean age of participants was $75.89 \pm 7.14$ years (range age: 65–98 years); a 64.30% were female; and a 54.30% of the total sample had Primary–Secondary educational level. Dividing the sample into age groups, we observed that the sample was approximately separated into two halves in the 65–75 and 75+ year-old groups.

**Table 1.** Demographic characteristics of the study sample.

| | Total ($n = 311$) |
|---|---|
| Age # | $75.89 \pm 7.14$ |
| *Age groups* | |
| 65–75 years | 158 (50.8) |
| 75 and older | 153 (49.3) |
| Gender, n (% female) | 200 (64.30) |
| Years of education # | $8.44 \pm 2.84$ |
| *Educational level, n (%)* | |
| Illiterate | 95 (30.50) |
| Primary–Secondary education | 169 (54.30) |
| Higher education | 47 (15.1) |
| Living with his/her partner, n (%) | 179 (57.60) |
| Number of alive children[a] | $2.36 \pm 1.91$ |
| *Living with someone, n (%)* | |
| Alone | 61 (19.90) |
| With one relative/friend | 179 (58.30) |
| With at least with two people | 61 (19.90) |
| With more than two people | 6 (2.00) |

*Note.* [a]Mean ±Standard deviation.

**Table 2.** Neuropsychological characteristics of the total study sample and age-divided groups.

| | Total (n = 311) | 65–75 years old group | 76 and older group | P value |
|---|---|---|---|---|
| MMSE | 26.14 ± 3.57 | 26.78 ± 3.19 | 25.42 ± 3.84 | 0.001 |
| Benton Temporal Orientation Test | 104.07 ± 21.82 | 106.29 ± 19.00 | 101.59 ± 24.43 | 0.064 |
| ECR Test – Original | 14.94 ± 1.90 | 15.27 ± 1.21 | 14.57 ± 2.40 | 0.002 |
| ECR Test – Modified | 44.43 ± 4.76 | 45.06 ± 3.82 | 43.70 ± 5.58 | 0.015 |
| Identification Phase | 14.82 ± 1.89 | 15.01 ± 1.80 | 14.61 ± 1.97 | 0.069 |
| Immediate Recall Phase | 14.56 ± 2.40 | 14.75 ± 2.08 | 14.34 ± 2.71 | 0.143 |
| Free and Cued Recall Phase | 14.94 ± 1.89 | 15.27 ± 1.21 | 14.57 ± 2.40 | 0.002 |
| Clock Drawing test | 5.56 ± 2.00 | 5.99 ± 1.61 | 5.08 ± 2.27 | 0.000 |
| Category Fluency | 14.65 ± 5.87 | 15.43 ± 6.23 | 13.77 ± 5.32 | 0.014 |

Note. $M \pm SD$ = Mean ± Standard deviation; MMSE = Mini-Mental State Examination; ECR = Enhanced Cued Recall.

Likewise, in Table 2, mean and standard deviations for the MMSE and 7 Minute Screen subtests scores of the total and age groups study sample are shown. Inferior scores are presented by the oldest group in all cognitive tests; however, only in the Benton Temporal Orientation Test, are no statistically significant differences of Identification and Immediate Recall phases found ($p > 0.05$).

## Confirmatory factor analyses

Prior to conducting the individual CFA analyses for each phase of the ECR test (Identification, Immediate Recall, and Free and Cued Recall), four items were deleted (foot, desk, shoe, and guitar). When analyzing the correlation coefficients for these four items, we considered eliminating those that behaved worse and had low coefficients.

Subsequently, to analyze the goodness of fit for each one of the three phases of the ECR test, a CFA for each individual phase was carried out. The results show that each CFA solution presents an acceptable fit. Indices for goodness of fit for each factor solution are presented in Table 3.

According to $\chi^2$, CMIN and CMIN/df indices, Identification, Immediate Recall, and Free and Cued Recall Phases have an acceptable fit. CFA results indicate that the CFI, IFI, and NFI indexes for each phase are acceptable because they are close to or higher than .90. The GFI index is adequate, although it is lower than .90. The RMR values indicate that the models fit well, however RMSEA data are contradictories. According to AIC, Identification and Free and Cued Recall phases show a better fit index as they are lower.

## Internal consistency and correlations between phases of the ECR task

Cronbach's alpha for each phase of the ECR was conducted. We obtained that Cronbach's alpha for Identification phase was 0.98; for Immediate Recall was 0.96; and for Free and Cued Recall was 0.94. Each phase shows a high internal consistency. Cronbach's alpha for the global subtest was 0.981, which indicates a high internal consistency and good reliability of the ECR test.

Finally, correlations between phases of the test (Table 4) support the factorial rotation chosen given that their values are statistically significant ($p < 0.05$).

## Effect of age and educational level on subtests of 7 Minute Screen Test

After performing the analyses, as it can be seen in Table 5, we found that there is a negative significant correlation between age and all 7MS subtests ($p < .01$); however, only the correlation between the Clock Drawing Test and age is moderate. Likewise, positive significant correlations between educational level and 7MS subtests were found ($p < .01$). Taking into consideration these results, it could be considered that a higher age has a negative effect on neuropsychological performance and a higher educational level has a positive effect on it.

**Table 4.** Inter-phase correlations for the Identification, Immediate Recall, and Free and Cued Recall Phases of the Enhanced Cued Recall Test.

| | Identification Phase | Immediate Recall Phase |
|---|---|---|
| Immediate Recall Phase | 0.28[*] | – |
| Free and Cued Recall Phase | 0.41[*] | 0.21[*] |

*Correlations are significant at the $p < .001$ level.

**Table 3.** Fit indices for each Identification, Immediate Recall, and Free and Cued Recall Phases of the Enhanced Cued Recall Test.

| | $\chi^2$ | CMIN | CMIN/df | GFI | CFI | IFI | NFI | RMSEA | RMR | AIC |
|---|---|---|---|---|---|---|---|---|---|---|
| Identification | 84.51 | 84.51 | 1.60 | .75 | .91 | .92 | .85 | .14 | .01 | 154.51 |
| Immediate Recall | 141.40 | 141.40 | 3.44 | .79 | .89 | .89 | .85 | .22 | .02 | 215.41 |
| Free and Cued Recall | 73.40 | 73.37 | 1.88 | .78 | .93 | .93 | .87 | .13 | .01 | 151.37 |

Note. $\chi^2$ = Chi-square test statistic; CMIN = Minimum discrepancy; CMIN/df = Minimum discrepancy divided by degrees of freedom; GFI = Goodness-of-Fit Index; CFI = Comparative-Fit Index; IFI = Incremental-Fit Index; NFI = Normed-Fit Index; RMSEA = Root Mean Square Error of Approximation; RMR = Root Mean Square Residual; AIC = Akaike's Information Criterion.

**Table 5.** Correlations and coefficients of determination between subtests of 7 Minute Screen Test  and age, and educational level.

| | Age | | Educational level | |
|---|---|---|---|---|
| | R | R² | R | R² |
| Benton Temporal Orientation Test | −.22* | .05 | .20* | .04 |
| ECR Test – Original | −.31* | .09 | .20* | .04 |
| ECR Test – Modified | −.27* | .08 | .30* | .09 |
| Identification Phase | −.29* | .09 | .27* | .07 |
| Immediate Recall Phase | −.16* | .03 | .22* | .05 |
| Free and Cued Recall Phase | −.31* | .09 | .20* | .04 |
| Clock Drawing Test | −.38* | .15 | .31* | .10 |
| Category Fluency | −.29* | .08 | .34* | .12 |

*Correlations are significant at the $p < .001$ level. ECR = Enhanced Cued Recall.

## Discussion

CFA conducted for each Identification, Immediate Recall, and Free and Cued Recall phases of the ECR support the separation of the ECR in three individual phases to be taken into account for scoring on the global test. Goodness of fit indices indicate that the results obtained in the CFA analyses are consistent with the independence of the phases and its necessity in assessing test performance, as each one shows an aspect involved in the temporal sequence of the mnesic process.

The first phase, Identification, is linked to the task of identifying the stimuli and not to the memorization process related to the stimuli. By orally administering the semantic clue, an association between a given item and clue can be created. The second stage, the Immediate Recall phase, corresponds to the storage and retention of the information identified in the Identification Phase. The third stage, Free and Cued Recall, involves two different types of recovery of the information stored in the two previous phases: free recovery and cued recovery, which occurs when the semantic clues given in the first phase of the test are repeated.

As Buschke suggested (Buschke, 1987), in memory tasks where visual or verbal stimuli are presented and the subject has to recall them in the immediate and long term, there are three phases: appreciation, learning and memory, and output. Our results also show three phases that conceptually correspond to each stage that this author proposed. First, we name the Identification Phase as such because we consider that a visual search and denomination of items is produced (Grober, Lipton, Hall, & Crystal, 2000) along with an identification and recognition process involving the items. That is, in this phase, we can determine whether a subject presents a gnosic deficit in the identification of the stimuli (Unzueta-Arce et al., 2014). Second, the Immediate Recall phase corresponds to a codification process of the stimuli and their associated semantic clues and their storage, processes that are interdependent (Schacter & Tulving, 1982). In the last phase,

Free and Cued Recall, a recovery of the stored information is made, first freely and afterward through facilitation involving the clues for those items that were not freely recovered. In this phase, it is shown who can make use of the semantic clues associated with the drawings. This allows us to discriminate genuine memory deficits from apparent memory deficits.

Thus, it is clear that, even if controlling for encoding and clues associated with a given stimuli, a patient with a genuine memory deficit cannot make use of either and will perform poorly. However, we are interested in identifying apparent memory deficits. Given our CFA results indicating that there are three independent phases in the ECR test, it is possible that poor performance in each phase could be a reflection of different cognitive impairments. Study and analysis of the scores obtained in each phase could assess two different things. First, we could separately study each one of the components that are part of the memory process that ECR assesses, that is, identification, immediate recall, and long-term recall processes. Second, we could study the following cognitive impairments that may separately emerge in these processes: a gnosic impairment (incapacity to identify the stimuli presented); a linguistic impairment (an item denomination failure); a working memory impairment (immediate recall of drawings failure); or a long-term memory impairment (a failure in free and cued recall of the items). Finally, a more specific mnemonic deficit could be examined in the last phase according to the type of recall used (free or cued). Deficit in accessibility and availability would probably be reflected on differences between free and cued recall performance (Habib & Nyberg, 2008); likewise, free recall could be impaired compared to cued recall if patient presents difficulties on executive functioning and. Consequently, the use of less efficient learning strategies (Noel et al., 2012).

The possibility of scoring and studying each phase of the ECR test separately could allow for establishing different patterns in the assessed patients. It would be notable if we could determine different cognitive patterns from the ECR test so as to discriminate between MCI subtypes and dementia and between different type of dementia such as Alzheimer's disease and subcortical vascular dementia (Graham, Emery, & Hodges, 2004; Saka, Mihci, Topcuoglu, & Balkan, 2006).

On the other hand, performance on 7 Minute Screen should be interpreted according to the age and educational level of the patient. As we found, age seems to have a negative effect on cognitive performance in 7MS subtests, which means that it is expected if older age, worse cognitive scores; a reversed effect would have the educational level: if higher educational, better performance on 7MS subtests. This seems to support

the idea that cognitive screening tests are influenced by certain sociodemographic variables (Freitas et al., 2012). However it would be interesting to study if different age and educational levels related patterns could be found according to cognitive domains to better understand this relationship (Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000).

One of the strengths of this study is the consideration of eliminating the four items that distorted the matrix. We believe that this distortion could be due to the degree of item difficulty and a ceiling effect. These items do not show a good discriminative capacity among participants. Deletion of these items could be beneficial, as it may result in time saving during test application, and according to Pike and Savage (2008), the presence of this ceiling effect would difficult the detection of significant differences in patients with cognitive impairment.

However, this study has some limitations. One of them refers to the lack of a clinical usefulness study that this individual's value proposal can have. From a clinical neuropsychological perspective, knowing if a patient presents impairment in the visual identification, short term or long term recall capacities could suggest different pathologies and this fact can guide toward a specific neuropsychological assessment of the deficit.

In conclusion, the analysis carried out in this study reveals that the ECR test is formed by three different phases (Identification, Immediate Recall, and Free and Cued Recall) that would be convenient to be separately scored. Each phase is necessary for the application of the test because they are each a part of the encoding and recovery processes of the information contained in the test. From this study, we propose to record the answers given by the patients in all three phases and to use these values to qualitatively interpret the results obtained and take into account the effect that age and educational level could have on the cognitive performance. In future work, a detailed study of the effectiveness of scoring each individual phase of the test could be carried out by comparing different diagnostic groups, as well as a broader analysis of the age and educational level effect by cognitive domains could be performed.

## Declaration of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

## Acknowledgments

## Funding

## References

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

Ardila, A., Ostrosky-Solis, F., Rosselli, M., & Gomez, C. (2000). Age-related cognitive decline during normal aging: The complex effect of education. *Archives of Clinical Neuropsychology*, *15*(6), 495–513. doi:10.1016/s0887-6177(99)00040-2

Benton, A. (1983). *Contributions to neuropsychological assessment*. New York, NY: Oxford University Press.

Buschke, H. (1987). Criteria for the identification of memory deficits: Implications for the design of memory tests. In D. S. Gorfein & R. R. Hoffman (Eds.), *Memory and learning. The ebbinghaus centennial conference* (pp. 331–344). Hillsdale, NJ: Lawrence Erlbaum.

Cabeza, R., & Moscovitch, M. (2013). Memory systems, processing modes, and components: Functional neuroimaging evidence. *Perspectives on Psychological Sciences*, *8*(1), 49–55. doi:10.1177/1745691612469033

Carnero-Pardo, C. (2013). Should the Mini-Mental State Examination be retired? *Neurologia*, *29*, 473–481. doi:10.1016/j.nrl.2013.07.003

Drake, M., Butman, J., Fontan, L., Lorenzo, J., Harris, P., Allegri, R. F., & Ollari, J. A. (2003). Screening for mild cognitive impairment: usefulness of the 7-minute screen test. *Actas Españolas de Psiquiatría*, *31*(5), 252–255.

Ecklund-Johnson, E., Miller, S. A., & Sweet, J. J. (2004). Confirmatory factor analysis of the behavioral dyscontrol scale in a mixed clinical sample. *The Clinical Neuropsychologist*, *18*(3), 395–410. doi:10.1080/1385404049052415

Fleming, J. S. (2005). TETCORR: A computer program to compute smoothed tetrachoric correlation matrices. *Behavior Research Methods*, *37*(1), 59–64. doi:10.3758/bf03206398

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12(3), 189–198.

Freedman, M., Leach, L., Kaplan, E., Winocur, G., Shulman, K., & Delis, D. (1994). *Clock drawing: A neuropsychological analysis*. New York, NY: Oxford University Press.

Freitas, S., Simoes, M. R., Alves, L., & Santana, I. (2012). Montreal cognitive assessment: Influence of sociodemographic and health variables. *Archives of Clinical Neuropsychology*, 27(2), 165–175. doi:10.1093/arclin/acr116

Freitas, S., Simoes, M. R., Alves, L., & Santana, I. (2013). Montreal cognitive assessment: Validation study for mild cognitive impairment and Alzheimer disease. *Alzheimer Disease and Associated Disorders*, 27(1), 37–43. doi:10.1097/WAD.0b013e3182420bfe

Graham, N. L., Emery, T., & Hodges, J. R. (2004). Distinctive cognitive profiles in Alzheimer's disease and subcortical vascular dementia. *Journal of Neurology, Neurosurgery and Psychiatry*, 75(1), 61–71.

Grober, E., Buschke, H., Crystal, H., Bang, S., & Dresner, R. (1988). Screening for dementia by memory testing. *Neurology*, 38(6), 900–903.

Grober, E., Lipton, R. B., Hall, C., & Crystal, H. (2000). Memory impairment on free and cued selective reminding predicts dementia. *Neurology*, 54(4), 827–832. doi:10.1212/wnl.54.4.827

Habib, R., & Nyberg, L. (2008). Neural correlates of availability and accessibility in memory. *Cerebral Cortex*, 18(7), 1720–1726. doi:10.1093/cercor/bhm201

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guildford Press.

Lobo, A., Saz, P., Marcos, G., Dia, J. L., de la Camara, C., Ventura, T., … Aznar, S. (1999). Revalidation and standardization of the cognition mini-exam (first Spanish version of the Mini-Mental Status Examination) in the general geriatric population. *Medicina Clinica*, 112(20), 767–774.

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack, C. R., Jr., Kawas, C. H., …Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, 7(3), 263–269. doi:10.1016/j.jalz.2011.03.005

Meguro, K., Shimada, M., Yamaguchi, S., Ishizaki, J., Yamadori, A., & Sekita, Y. (2001). A 5-year retrospective examination of cognitive screening test stages in normal older adults and patients with Alzheimer's disease: The Tajiri project. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 56(5), P314–P318. doi:10.1093/geronb/56.5.p314

Meulen, E. F., Schmand, B., van Campen, J. P., de Koning, S. J., Ponds, R. W., Scheltens, P., & Verhey, F. R. (2004). The seven minute screen: A neurocognitive screening test highly sensitive to various types of dementia. *Journal of Neurology, Neurosurgery & Psychiatry*, 75(5), 700–705. doi:10.1136/jnnp.2003.021055

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100. doi:10.1006/cogp.1999.0734

Mora-Simon, S., Garcia-Garcia, R., Perea-Bartolome, M. V., Ladera-Fernandez, V., Unzueta-Arce, J., Patino-Alonso, M. C., & Rodriguez-Sanchez, E. (2012). Mild cognitive impairment: early detection and new perspectives. *Revista de Neurología*, 54(5), 303–310.

Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., … Chertkow, H. (2005). The Montreal cognitive assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society* 53(4), 695–699. doi:10.1111/j.1532-5415.2005.53221.x

Noel, X., Van der Linden, M., Brevers, D., Campanella, S., Hanak, C., Kornreich, C., & Verbanck, P. (2012). The contribution of executive functions deficits to impaired episodic memory in individuals with alcoholism. *Psychiatry Research*, 198(1), 116–122. doi:10.1016/j.psychres.2011.10.007

Pike, K. E., & Savage, G. (2008). Memory profiling in mild cognitive impairment: Can we determine risk for Alzheimer's disease? *Journal of Neuropsychology*, 2(2), 361–372. doi:10.1348/174866407X227015

Rodriguez-Sanchez, E., Mora-Simon, S., Patino-Alonso, M. C., Garcia-Garcia, R., Escribano-Hernandez, A., Garcia-Ortiz, L., … Gomez-Marcos, M. A. (2011). Prevalence of cognitive impairment in individuals aged over 65 in an urban area: DERIVA study. *BMC Neurology*, 11, 147. doi:10.1186/1471-2377-11-147

Sabe, L., Jason, L., Juejati, M., Leiguarda, R., & Starkstein, S. (1993). Sensitivity and specificity of the Mini-Mental State Exam in the diagnosis of dementia. *Behavioural Neurology*, 6(4), 207–210. doi:10.3233/ben-1993-6405

Saka, E., Mihci, E., Topcuoglu, M., & Balkan, S. (2006). Enhanced cued recall has a high utility as a screening test in the diagnosis of Alzheimer's disease and mild cognitive impairment in Turkish people. *Archives of Clinical Neuropsychology*, 21(7), 745–751. doi:10.1016/j.acn.2006.08.007

Schacter, D. L., & Tulving, E. (1982). Amnesia and memory research. In L. Cermak (Ed.), *Human memory and amnesia* (pp. 1–32). Hillsdale, NJ: Lawrence Erlbaum.

Siedlecki, K. L., Honig, L. S., & Stern, Y. (2008). Exploring the structure of a neuropsychological battery across healthy elders and those with questionable dementia and Alzheimer's disease. *Neuropsychology*, 22(3), 400–411. doi:10.1037/0894-4105.22.3.400

Solomon, P. R., Hirschoff, A., Kelly, B., Relin, M., Brush, M., DeVeaux, R. D., & Pendlebury, W. W. (1998). A 7 minute neurocognitive screening battery highly sensitive to Alzheimer's disease. *Archives of Neurology*, 55(3), 349–355.

Solomon, P. R., & Pendlebury, W. W. (1998). Recognition of Alzheimer's disease: The 7 minute screen. *Family Medicine*, 30(4), 265–271.

Unzueta-Arce, J., Garcia-Garcia, R., Ladera-Fernandez, V., Perea-Bartolome, M. V., Mora-Simon, S., & Cacho-Gutierrez, J. (2014). Visual form-processing deficits: A global clinical classification. *Neurologia*, 29, 482–489. doi:10.1016/j.nrl.2012.03.006