

Original

Prospective memory in patients with Mild Cognitive Impairment

Memoria prospectiva en pacientes con deterioro cognitivo leve

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Abstract

Prospective memory is the ability to remember to carry out intended actions and to evoke delayed intentions. It constitutes a crucial skill for the daily functioning of the elderly. It might also be prematurely compromised in neurodegenerative diseases. In the Latin American region, objective measures are not available for its assessment. The aim of this study is to explore prospective memory in patients diagnosed with Mild Cognitive Impairment. As specific aims, we intend to discriminate the performance on prospective memory between patients and healthy subjects and to study the internal consistency and inter-examiner reliability of the Mini Códor Test (a simplified version of a prospective memory test developed in Argentina). We carried out a comparative study including a group of 20 patients with Mild Cognitive Impairment and a group of 20 healthy subjects as control group. Results indicated significant statistical differences between groups in prospective memory performance in favor of the control group. The Mini Códor Test met adequate scores for internal consistency and inter-rater reliability. These preliminary results suggest that the Mini Códor Test has the potential to early detect cognitive impairment associated to neurodegenerative pathology.

Keywords: Prospective memory; Mild Cognitive Impairment; reliability; delayed intentions

Resumen

La memoria prospectiva es la capacidad de recordar llevar a cabo acciones previstas o de evocar intenciones demoradas. La misma, constituye una habilidad crucial en el funcionamiento de la vida cotidiana de los adultos mayores. Además, puede verse comprometida de manera prematura en el proceso neurodegenerativo. En la región latinoamericana, no existen medidas objetivas para su correcta valoración. El objetivo general del presente trabajo es explorar la memoria prospectiva en pacientes diagnosticados con Deterioro Cognitivo Leve (DCL), mientras que los objetivos específicos son discriminar su rendimiento entre controles y pacientes con DCL y establecer la consistencia interna y la confiabilidad inter-examinador del test Mini Códor (versión simplificada de una prueba de memoria prospectiva desarrollada en Argentina). Se realizó un estudio comparativo de muestras independientes, con un grupo de 20 pacientes diagnosticados con DCL y un grupo control de 20 sujetos sanos. Los resultados indicaron que los grupos presentaban diferencias estadísticamente significativas en el desempeño de memoria prospectiva a favor del grupo control y que el test Mini Códor reunía adecuados índices de consistencia interna y de confiabilidad inter-evaluador. Estos resultados preliminares indican que el test Mini Códor tiene el potencial para detectar tempranamente el deterioro cognitivo asociado a patología neurodegenerativa.

Palabras claves: Memoria prospectiva; Deterioro Cognitivo Leve; confiabilidad; intenciones demoradas

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INTRODUCTION

Prospective memory is the ability to remember to perform future-oriented actions. It is an essential cognitive function for functional autonomy, either for maintaining an active social life or for carrying out complex activities (Kliegel et al., 2008). It can also be defined as the capacity to self-monitor signs that might indicate carrying out a planned action (Ellis & Kvavilashvili, 2000).

Prospective memory allows to conduct previously planned actions or to remember delayed intentions, with a variable time lapse between the planning of the action and its performance, within a given spatiotemporal context (Nurdal et al., 2020). These intentions, which function as trigger indicators of the planned action, can be based on events, when the environment is monitored to detect the signal that reveals the need to carry out an action (for example, an image of the grocery store might evoke the action to buy apples), or can be based on time, when the time lapse gives the signal (for example, attending an appointment at 5 p.m.) (Kliegel et al., 2001).

The tasks used to assess this type of memory include two components: a retrospective one, which refers to the content of the intention, and a prospective one, which is linked to the self-initiation of the action required through the signal that establishes the beginning of it (Grandi & Tirapu-Ustárroz, 2017). In the given example of the grocery store, the retrospective component would be to remember what to buy. The difference between these two is that while retrospective memory is associated to the ability to recall autobiographical information, prospective memory is related to the memory of late intentions (Smith-Spark et al., 2016). It is because of this that their assessment differs: in tasks used to evaluate prospective memory, the examinee has to evoke certain information at a preset moment, while as in tasks that assess retrospective memory, is the examiner who request for the recall of the information. For a long time, previous studies have studied the retrospective memory, not giving prospective memory a predominant place. However, currently research has begun to give greater importance to those neurocognitive processes underlying late actions, since they are considered essential for functional independence (Grandi & Tirapu-Ustárroz, 2017).

In the assessment of prospective memory, subjects are instructed to perform certain actions while they solve other background tasks, known as concurrent tasks. The examinees have to initiate the prospective memory activity while solving the distracting task. The examiner does not account for the moment in which the prospective memory task must be initiated, so that they have to initiate it themselves without any type of warning. In time-based intentions, the activity must be initiated once a certain period of time, previously agreed with the examiner, has elapsed (Cores et al., 2010), while as in event-based intentions, the examinees have to wait for the appearance of an external signal, which will generate access to the memory trace (Grandi & Tirapu-Ustárroz, 2017).

The type of processing that that prospective memory tasks require can also differ. Mc Daniel & Einstein (2000) have established a multiprocessing model, which distinguishes between two different types of processing: automatic and strategic.

These ones will also depend on certain characteristics of the task, such as if it is focal or non-focal. If it is focal, the self-initiation process will be facilitated, since the signals are immersed in the concurrent task. When the signals are not inserted in the distracting task, a strategic process takes place, as the activity is more demanding due to the need of a greater attentional control. A successful performance in this cognitive ability depends on different functions, such as the ability to initiate the action in the prescribed time, the recovery of the activity to be carried out, the planning, and the inhibition of automatic actions (Cockburn & Smith, 1989).

Taking into account the studies developed by Ellis in 1996, Kliegel et al. (2000) designed a model through which he considered prospective memory as a skill consisting of three phases: a) the formation, encoding and planning of the intention, b) the storage of the intention, being its duration variable (minutes, hours, days) and c) the auto-initiation of the task and its execution.

Mild Cognitive Impairment (MCI), in the majority of cases, can be the prodromal phase of Alzheimer's Disease (AD). Prospective memory is usually compromised in patients with MCI at early stages (Pereira et al., 2015). For the assessment of this type of memory, cognitive tests have been developed. Examples of these are the Memory for Intentions Screening Test (MIST) (Raskin, 2004), and the Rivermead Behavioral Memory Test (RBMT) (Wilson et al., 1991), that includes items intended to measure prospective memory. However, the Latin American region does not have enough instruments to assess it, leading the research field to measure prospective memory by laboratory tests and self-referential questionnaires, such as the Prospective and Retrospective Memory Questionnaire (González-Ramírez y Mendoza-González, 2011), which do not reflect the objective performance of patients (Cores et al., 2017).

Several studies have shown that successful performance in prospective memory is consistently associated to age, as older adults are less precise than younger adults in the cognitive tasks used for its measurement (Mioni et al., 2020). Also, there is a significant difference between the performance of healthy older adults and patients with MCI (Costa et al., 2011). In patients with AD, it has been reported that prospective memory is impaired in both automatic recovery processes and controlled strategic processes (Lecouvey et al., 2019). This is why tasks which involves recall at a later timer are particularly sensitive at the early stages of dementia (Troyer & Murphy, 2007). Nevertheless, it is necessary to continue the research in this matter, as a consensus on the components and phases that are affected by prospective memory in MCI and AD has not yet been reached.

Prospective memory has a significant impact on activities of daily life, which maintain functional autonomy (Chasteen et al., 2001), so that the importance to study this type of memory lies in the fact that it can be considered a useful predictor of daily functioning in older adults. Initially it was measured through tests that, although they contained items used for its assessment, were not developed exclusively for it, such as the RBMT. In 2000, the Virtual Week Test was published (Rendell & Craik, 2000). This test attempts to recreate prospective memory tasks of daily living through a board game. Raskin (2004) developed the MIST as a short measure for

prospective memory. These last two tests were used in numerous investigations and with various clinical populations. [Wilson et al. \(2005\)](#) created the first test designed for a clinical environment, called the Cambridge Prospective Memory Test (CAM-PROMPT), which assess future recall through six different tasks, both time-based and event-based. In 2011, two new cognitive tests were published: The Ecological Test of Prospective Memory ([Potvin et al., 2011](#)), and the Royal Prince Alfred Prospective Memory Test (RPA- ProMem), developed by [Radford et al. \(2011\)](#). These two have not yet managed to obtain significant growth in the scientific field. In the Latin American region, none of the described tests have been able to be used in clinical environments, as they lack of translations, adaptations and adequate psychometric properties for the target populations. There is a need for a reliable and validated prospective memory test to be used in this region.

The Cóndor Test is a measurement of delayed intentions ([Meyer, 2002](#)), developed in the Argentinian region. It has shown to be useful for the assessment of early cognitive changes in ageing and for the differentiation between healthy adults and those with benign forgetfulness ([Parente et al., 2005](#)), and between healthy adults and patients with Multiple Sclerosis (MS) ([Meyer et al., 2002](#)). In this test, the examinee has to read a text with neutral emotional content while executing a series of instructions throughout the session. These tasks are both time-based and event-based. A short and simplified version of the test was created, called the Mini Cóndor Test ([Cores et al., 2021](#)). It intends to measure prospective memory in an elderly, low-educational population from a hospital in the suburbs of Buenos Aires, Argentina.

The aim of this research is to explore prospective memory in patients diagnosed with MCI. It is also intended to establish the internal consistency and inter-examiner reliability of the Mini Cóndor Test. It is expected to observe a worse performance in the Mini Cóndor Test of patients with MCI in comparison to healthy adults and adequate indexes of internal consistency and inter-examiner reliability as regard the test.

METHODOLOGY

This study follows the guidelines of a cross-sectional prospective design with non-probabilistic intentional sampling where the investigator chooses the patients according to a certain criteria ([Otzen & Manterola, 2017](#)).

Participants

A total of 40 subjects of Argentine nationality residing in Buenos Aires were recruited. 20 had a diagnosis of MCI according to the National Institute on Aging and Alzheimer's Association (NIA-AA), of which 8 had amnesic MCI and 12 had non-amnesic MCI, and 20 were healthy subjects, who were non-consanguineous relatives or companions of the patients that attended the hospital. Both groups were matched by age (+ 2 years) and by education (+ 2 years).

The inclusion criteria for the experimental group were the following: meet criteria for MCI diagnosis, age greater than or equal to 65 years old, education less than or equal to 12 years, score greater than or equal to 22 points on the Mini Mental State Examination (MMSE) (Folstein et al., 1975), and a scores lower than or equal to 0.5 on the Clinical Dementia Rating (CDR) (Hughes et al., 1988). All patients had a complete cognitive evaluation, which confirmed cognitive deterioration compatible with the diagnosis. The following tests were administrated: CDR, MMSE, Clock Test, California Verbal Learning Test (CVLT) (Artiola et al., 1999), Phonological and Semantic Verbal Fluencies (Artiola et al., 1999), Digits (Artiola et al., 1999), Rey Complex Figure Test (Meyers & Meyers, 1995), Boston Test (Kaplan et al., 1938), and Trail Making Test (Reitan, 1958).

For the control group, the following inclusion criteria was established: age greater than or equal to 65 years old, education less than or equal to 12 years, score greater than or equal to 24 points on the MMSE and score of greater than or equal to 12 points on the Clock Test. The exclusion criteria for all participants were: not being literate, having hearing or visual deficits, history of alcoholism or substance abuse, brain injury, psychiatric illness and/or mental retardation.

Instruments

The Mini Condor Test consists of reading a short text of neutral emotional content about the condor bird. It contains two time-based items and two event-based items. The examinee has to read the text aloud while responding to instructions related to future intentions. During the administration of the test, the subject sits in front of a table, where the examiner places two sheets, one containing the written history and the other one the instructions, and a black pencil. On the table, is a digital clock and a red box with black tiles. Then the following instruction is given:

Here is a story. I want you to read it out loud and try to understand and memorize what you read. While you are reading, I am going to ask you to do some things. I am going to guide you. Start reading from here (point the title of the text).

When pointed at the story sheet, the examinee must read the instructions given. After the subject reads each one, he will have to remember to do it himself, as the examiner cannot tell him when to initiate the action.

The instructions consist of the following:

1. Underline the word “condor” each time it appears in the text (maximum 4 points).
2. Write its own name on the sheet after two minutes reading. The clock may be watched as many times as needed (maximum 2 points).
3. Keep a blank sheet in the pocket when given by the examiner (maximum 2 points). Before the subject leaves the room, he has to return the sheet (maximum 2 points).

4. After eight minutes reading, the examinee has to take a token from the red box and give it to the examiner. The clock may be watched as many times as needed (maximum 2 points).

The total score of the test has a maximum of 12 points.

During the delay period that this test requires, all participants completed a series of tests and questionnaires: the Mini Geriatric Depression Test (GDS-15) (Sheik & Yesavage, 1986), the Accentuation of Words Test (TAP-R) (Sierra et al., 2010), and the Beck Anxiety Inventory (BAI) (Beck et al., 1988).

Procedure

Participants were recruited from a hospital in Buenos Aires during the year 2021. Patients with MCI were assessed in two sessions, while healthy subjects were evaluated in one session. These sessions were carried out only with the patient and the examiner present in the room.

All participants signed an inform consent, agreeing to participate voluntarily in this study. After the administration of the tests, a database was created and the statistical analyses were carried out.

Statistical Analyses

Means (M) and Standard Deviations (SD) are described in order to report the chosen sample. The variables of interest were analyzed through the statistical software IBM SPSS Statistics (v. 25). As the sample taken demonstrate to have a normal distribution, the Student's t Test was used to compare between groups. Inter-examiner reliability was measured through the Intraclass Correlation Coefficient Index (ICC), whereas the internal consistency of the Condor Test was measured through Cronbach's Alpha.

RESULTS

Samples' description

TABLE 1. *Demographic data*

	<i>EG</i>	<i>CG</i>
<i>N</i>	20	20
Females	75%	60%
Education M (<i>SD</i>)	7.10 (1.971)	7.25 (2.900)
Age M (<i>SD</i>)	73.65 (5.264)	73.80 (5.493)
Differences in Age	$p = .916; t = .088; lg = 38$	
Differences in Education	$p = .362; t = .191; lg = 38$	

Note: *EG* = Experimental Group (patients with MCI);
CG = Control Group (healthy subjects); *M* = Mean; *SD* = Standard Deviation.

Regarding gender, no significant differences were found between groups [$X^2(1) = 1.026, p = .501$]. Table 1 shows the demographic data of the samples taken.

Comparison between groups at prospective memory

The t test for independent samples showed significant differences between the groups in favor of the control group (Table 2).

TABLE 2. *Sample's Analysis.*

N	M	(SD)	T	lg	p	d of Cohen
EG	20	7.30 (3.658)	2.19	29.72	.036	0.9
CG	20	9.35 (2.033)				

Note: EG = Experimental Group (patients with MCI);
CG = Control Group (healthy subjects); M = Mean; SD = Standard Deviation.

Reliability

An alpha of .80 was obtained when calculating the internal consistency of the Mini Condor Test. The inter-examiner reliability was statistically significant ($p < .001$) and the interclass correlation coefficient was considered as excellent ($ICC = .989$).

CONCLUSIONS

The aim of this study was to explore prospective memory in patients diagnosed with MCI, while the specific objectives were to discriminate prospective memory performance between healthy subjects and patients with MCI and to establish internal consistency and inter-examiner reliability of the Mini Condor Test.

Prospective memory is considered impaired in patients diagnosed with MCI, as they presented a worse performance at the prospective memory test in comparison to healthy participants.

There is a scarcity of adapted and validated instruments to measure this type of memory in the Spanish-speaking population. There are available questionnaires which request observations from family members and self-reports from patients, such as the Retrospective and Prospective Memory Questionnaire (González-Ramírez & Mendoza-González, 2011), but these not always reflect the performance at the objective tests, although they are considered useful to improve clinical impression (Cores et al., 2017). The Condor Test, used to evaluate prospective memory and developed for the Argentinian region, has proven to be successful in measuring correctly the cognitive changes of ageing as well as discriminating between healthy subjects, people with benign forgetfulness and patients with MS (Meyer, 2002).

An abbreviated version of The Condor Test, called The Mini Condor Test, was developed in order to obtain an adequate measure of prospective memory in the elderly and with low education population. Based on the results obtained in this research, it is concluded that prospective memory has the potential to early detect cognitive impairment in patients with MCI, since these had a worse performance compared to healthy patients. The first hypothesis stated is fulfilled, in agreement with previous studies (Kinsella et al., 2018; Niedzwienska et al., 2017). As regards the second hypothesis, the Mini Condor Test showed an adequate internal consistency of 0.80 as an excellent inter-examiner reliability index ($ICC = 0.989$).

The present investigation contributes to the cognitive evaluation of patients at risk of developing a neurodegenerative disease, such as Alzheimer's Disease. It also helps with the study of psychometric techniques in the field of neuropsychology, since the Mini Condor Test can be used to measure performance in future recall, which is essential to maintain functional independence, as different studies have showed that prospective memory has a significant impact on daily life activities (Chasteen et al., 2001).

It is necessary to continue the study on prospective memory and to add tests to the neuropsychology batteries to objectively measure it. Its assessment could help to detect cognitive changes in those individuals going through the early stages of dementia as well as to guide interventions and strategies for the elderly with cognitive impairment and at risk of dementia.

AUTHORS CONTRIBUTION

EVC: Conceptualization, Funding acquisition, Investigation, Project administration, Investigation, Methodology, Resources, Supervision, Writing – review & editing.

CC: Investigation, Methodology, Validation, Writing – original draft.

MR: Investigation, Methodology, Visualization, Writing – original draft.

LS: Investigation, Methodology, Data curation, Formal Analysis, Software.

DGP: Investigation, Methodology, Data curation, Formal Analysis, Software.

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