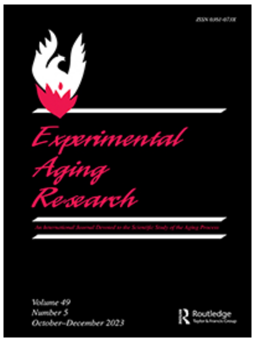

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Association Between Neuropsychological Functions and Activities of Daily Living in People with Mild Cognitive Impairment

Rogério Paulo dos Santos Henriques[a,b], Pablo Tomas-Carus[a,b], and José Francisco Filipe Marmeleira[a,b]

[a]Departamento de Desporto e Saúde, Escola de Saúde e Desenvolvimento Humano, Universidade de Évora, Largo dos Colegiais, Portugal; [b]Comprehensive Health Research Center (CHRC), Universidade de Évora, Largo dos Colegiais, Portugal

ABSTRACT

Objective: The aim of this study was to explore the relationship between performance in neurocognitive variables and daily functioning (basic or b- and instrumental or i-ADL) in people with mild cognitive impairment (MCI).
Methods: A sample of 157 participants with MCI (73.65 ± 7.58 years) completed a battery of tests for assessing ADL and cognitive functions. t-test, Pearson's correlation and multiple linear regression (backward stepwise selection) were used for data analyses.
Results: Significant correlations were found between b- and i-ADL, and several neuropsychological tests ($p < .01$). Multivariate analysis showed that difficulties in Blessed Rating Scales (BLS) explained 33.2% of the variation in b-ADL and that this variation rises to 42.9% when BLS is associated with Frontal Assessment Battery Flexibility, Trail Making Test A (TMT-A) and BLS Personality. For i-ADL, BLS and Dementia Rating Scale Total (DRS-T) explained 47.7% of the variation and the inclusion in the model of BLS, DRS-IP (Initiation/Perseveration), TMT-A and BLS Personality explained 53.5% of this variation. Executive functions explained 24.8% of the variation in i-ADL.
Conclusions: Cognitive functions are related to i- and b-ADL in people with MCI. The general indicators and those that assess executive functions and verbal- or visual-spatial memory should be considered to predict i-ADL.

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Introduction

Basic activities of daily living (b-ADL) are focused on personal care and self-maintenance skills, while instrumental activities of daily living (i-ADL) are more complex, by allowing the integration of a person in the community, managing their home and their life (Cornelis, Gorus, Beyer, Bautmans, & De Vriendt, 2017). The literature points out that i-ADL are more sensitive to the effects of mental decline (Bangen et al., 2010; Luck et al., 2011). Cognitive limitations are able to predict functional decline (Cornelis, Gorus, Van Schelvergem, & De Vriendt, 2019; Jekel et al., 2015; Pérès et al., 2008), even in the presence

CONTACT Rogério Paulo dos Santos Henriques rogeriopaulohenriques@gmail.com Departamento de Desporto e Saúde, Escola de Saúde e Desenvolvimento Humano, Universidade de Évora, Comprehensive Health Research Centre (CHRC), University of Évora, Portugal, Largo dos Colegiais, Portugal.

of subjective complaints of decline (Atkins et al., 2018; Roehr, Riedel-Heller, et al, 2019). Both b- and i-ADL can contribute to the diagnostic differentiation between cognitively healthy aging and neurocognitive disorders in old age (Cornelis et al., 2017).

Cognitive decline is not the inevitable result of aging; rather it is an impairment (Bangen et al., 2019; Lindeboom & Weinstein, 2004). The symptoms often appear in a continuum in which the impairment is functional, but cognitive too (Amanzio et al., 2018). Neurocognitive disorders can range from a mild to a major degree of limitations (American Psychiatric Association, 2013). The diagnosis of mild cognitive impairment (MCI) is made after evidence of a small degree of cognitive decline, from a previous level of performance, in one or more cognitive domains, such as complex attention, executive function, learning and memory, language, perceptual-motor function or social cognition (American Psychiatric Association, 2013). The diagnostic criteria also consider that the i-ADL are reasonably preserved, and that decline cannot be better explained by other mental disorders.

An association has been found between deficits in i-ADL and MCI, namely in those functions with higher cognitive demands (Perneczky et al., 2006; Reppermund et al., 2013, 2011; Schmitter-Edgecombe, McAlister, & Weakley, 2012). The i-ADL requiring more demanding neuropsychological functioning, such as financial capacity, appears to be more severely affected in patients with MCI. In particular, the reduction of i-ADL seems to be related with deficits in executive functions, namely in the ability to inhibit responses, self-monitoring and flexibility (Amanzio et al., 2018). It has been reported that executive functions are less related to b-ADL than to i-ADL (Cornelis et al., 2019). Recent studies have suggested that MCI patients made less advantageous decisions when the information was more complex and required the availability of executive functions (Pertl, Benke, Zamarian, & Delazer, 2017).

The question as to which mental functions are most often compromised in MCI is controversial. MCI and the initial stage of Alzheimer's Disease (AD) are marked by the progressive deterioration of episodic memory (Gainotti, Quaranta, Vita, & Marra, 2014; Loewenstein et al., 2006) and working memory (Aretouli & Brandt, 2010; Farias et al., 2006). Although memory complaints are one of the first clinical symptoms in patients with MCI, impaired planning (Labyt et al., 2004), inhibitory control (Brosseau, Potvin, & Rouleau, 2007; Seidler et al., 2010), memory and learning, visuomotor coordination and visuospatial processing has also been identified in such patients (Cornoldi, Bassani, Berto, & Mammarella, 2007; Drag et al., 2016; Tippett, Krajewski, & Sergio, 2007; Verheij et al., 2012). Additionally, emotional symptoms have been related with MCI (Burton, O'Connell, & Morgan, 2018; Ginsberg et al., 2019).

The association between functional impairment and neuropsychological variables is relevant for the diagnosis and prognosis of MCI (Amanzio et al., 2018). It is therefore very useful to compare the performance in different neuropsychological variables with the everyday functioning, reported by the patients themselves and by their caregivers (Jekel et al., 2015). The clinical stage of MCI worsens as ADL and neuropsychological functions become more compromised (Petersen et al, 2018). By knowing better the neuropsychological profile and the ADL impaired in the MCI, it is possible to anticipate proper interventions (Tulliani et al., 2019), including social community programs or training programs targeting specific cognitive functions. Furthermore, there have been few studies that attempted to predict ADL from other neuropsychological functions such as attention, visuospatial reproduction, abstraction, verbal and visuospatial memory and humor (Stephan et al., 2013).

Therefore, the aim of this study was to explore the relationship between performance in neurocognitive variables and daily functioning in b-ADL and i-ADL in people with MCI. Specifically, this investigation examined how these neurocognitive variables contribute to the variation of b-ADL and i-ADL.

Methods

Study Design and Participants

Participants in this cross-sectional, observational and quantitative study were recruited from five private clinics in the district of Santarém, in central Portugal. All participants requested the evaluation by the neuropsychology service throughout the years 2017, 2018 and 2019. Subsequently, between September and December 2019, all participants were contacted, having agreed to be included in this study and provided signed informed consent.

A total of 157 participants were selected based on the following inclusion criteria: a) adults over 60 years old; b) average values between 0.5 and 1.0 (very mild to mild dementia) on the Clinical Dementia Rating (Hughes, Berg, Danziger, Coben, & Martin, 1982); and c) being diagnosed with MCI according to the characteristics presented in the DSM-5 (American Psychiatric Association, 2013).

Procedures

The collection of cognitive and functional data was carried out over two sessions, with a duration of about one hour each. The questionnaires related to functionality were completed in the presence of the patient and the caregiver at the beginning of the first session. For the collection of neurocognitive data, the interviewer and the patient were present in a clinical office, free of excessive stimuli. Both the collection and the quotation of the data were performed by one of the authors of this article, who is a psychologist and has the advanced specialty of neuropsychology by the Portuguese Psychologists Order. The evaluation followed the 14 guidelines for the evaluation as defined by the American Psychological Association (American Psychological Association, 2012).

Instruments

Activities of Daily Living

- Katz index (b-ADL). The Daily Living Activities Index was developed to measure the physical functioning of patients with chronic illness (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). Six activities considered basic in everyday life were quoted: washing, dressing, using the toilet, mobility, being continent and eating (Chakraborty, 2018). Each activity receives a score from 1 (most independent level) to 3 (most dependent level). The total score of 6 indicates independence, 7–10 partial dependence, 11–17 dependence and above 17 total dependence.- Lawton-Brody scale (i-ADL). This instrument assesses the level of independence of the elderly person regarding instrumental activitiesHT (Lawton & Brody, 1969) and is a valid instrument for differentiating between decline and dementia (Roehr et al, 2019). It comprises eight tasks: using the phone, shopping, preparing meals, taking care of the house, washing clothes, using transportation, responsibility for own medication and the ability to handle money. The index varies between 8 and 30 points according to the following cutoff points: 8 points, independent; 9–20 points, moderately dependent and more than 20 points, severely dependent.

Clinical Evaluation

- Blessed Rating Scales (BLS). BLS were used to assess functional and emotional changes in patients with dementia. These scales assess changes in the performance of daily activities, habits, personality, interests and motivations. BLS have been validated through their correlation with neuropathological markers of AD (Blessed, Tomlinson, & Roth, 1968). Scores greater than 9 indicate typical dementia changes. When the diagnosis is not fully determined, it is expected to find indices of 4 to 9 points. Scores less than 4 determine the absence of decline.- Phototest. This test allows the detection of cognitive impairment and dementia. The Phototest has three sub-tests: denomination, verbal fluency and free and facilitated recall. It is very brief and easy do administer, applicable to illiterates, not influenced by educational variables and useful for the identification of cognitive impairment and dementia (Carnero Pardo, Carrera Muñoz, Triguero Cueva, López Alcalde, & Vílchez Carrillo, 2018; Carnero Pardo et al., 2011, 2007). According to the authors, the discriminative validity of the Fototest is good, equal to or greater than that of the generalized employment tests in our environment, with the advantage that it is not influenced by the educational level of the subjects. Scores below 28 may indicate cognitive impairment. – Dementia Rating Scale (DRS). This test consists of five subscales: Attention (DRS-A), Initiation/Perseveration (DRS-IP), Construction (DRS-Const), Conceptualization (DRS-C) and Memory (DRS-M) (Pedraza et al., 2010). The DRS is able to differentiate between patients with MCI, patients with mild AD and the control group (Jurica, Leitten, & Mattis, 2001; Woolf et al., 2016). The second version of DRS was considered a general measure of cognitive ability for adults with low levels of cognitive functioning and neurological cortical or subcortical changes of a degenerative type (Jurica et al., 2001; Pedraza et al., 2010; Woolf et al., 2016). The gross results of each sub-scale are converted into adjusted scores and scalar scores, which in the Portuguese version (Cavaco & Teixeira-Pinto, 2011), are adjusted for age and education. Scalar scores have the following clinical interpretation: 2 to 3, significant deficit; 4 to 5, moderate deficit; 6 to 8, slight deficit; 9 to 10, low average; 11 to 13, on average and 14 to 18 points, above average. It was considered a general measure of cognitive ability for adults with low levels of cognitive functioning and degenerative-type cortical or subcortical neurological changes (Jurica et al., 2001).- Rey-Osterrieth Complex Figure (ROCF). The objective of this test is the differential diagnosis between constitutional mental deficit and the deficit acquired as a result of traumatic brain injury (Cruz, Da, Toni, Marco de, & Daiani Martinho de, 2011). The ROCF allows the assessment of perceptual activity and visual memory (Kasai et al., 2006). The application takes place firstly in the presence of the figure. Soon after, with an interval of time not exceeding 3 minutes, the reproduction is made from memory. The total score results from the sum of all the points achieved by the subject.- Trail Making Test (TMT). The TMT has two parts: part A (TMT-A) measures attention, visual perception, visuo-motor speed and information processing while part B (TMT-B) evaluates working memory and executive functions (Cavaco et al., 2013; Lezak, Howieson, & Loring, 2004). This test is highly sensitive to a variety of neurological conditions and their preclinical manifestations, including dementia. Both TMT-A and TMT-B figures are composed of 25 circles, TMT-A numbered from 1 to 25 and TMT-B including numbers and letters. The task is to connect the circles in ascending order; in TMT-B it is also required alternating between numbers and letters. The result is obtained from the number of seconds required to complete the task.-Frontal Assessment Battery (FAB). This battery is a brief administration instrument, originally intended for the assessment of executive functions in patients with dementia. Includes 6 sub-tests that assess different skills: conceptualization, mental flexibility, programming, sensitivity to interference, inhibitory control and autonomy (Dubois, Slachevsky, Litvan, & Pillon, 2000; Hisano, 2018). Each subtest is rated with a maximum of 3 points, and the total score can reach 18 points. The score from 16 to 18 remains in the middle range, whereas scores below 15 may indicate a dysfunctional pattern in the frontal regions of the patient's brain.

- Beck Depression Inventory (BDI). BDI-II assesses the intensity of depression in clinical and non-clinical patients (Beck, Steer, & Brown, 1996). It is a measure of negative cognitions, that is, persistent, imprecise and intrusive negative thoughts about the self. Depression is understood by BDI-II as having two components, the affective and the physical or somatic. This inventory contains 21 questions scored from 0 to 3. Scores below 13 may indicate absence or minimal depression; from 14 to 19 mild; 20 to 28 moderate and 29 to 63 several depression.

Data Analysis

The assumption of normality regarding the distribution of the data of each variable was evaluated using the Kolmogorov-Smirnov test. Initially, a descriptive analysis of demographic and clinical characteristics was carried out. For the comparison of variables between the groups of dependent and independent participants (according to b-ADL and i-ADL scores), we used the t-test for independent samples. Pearson's correlation was used to analyze the intensity and direction of the relationship between the neuropsychological variables and the b-ADL and i-ADL scores. Correlation thresholds of 0.10 are small, 0.30 moderate and 0.50 high (Cohen, 1988).

For multivariate analysis, multiple linear regression (backward stepwise selection) was computed to examine which neuropsychological variables contribute significantly to the activities of daily living reflected in the b-ADL and i-ADL scores. Stepwise regression is used to select useful subsets of variables and to evaluate the order of importance of variables (Thompson, 1995). We developed seven linear regression models. For each model, b-ADL and i-ADL were considered separately as dependent variables. The independent variables considered were the general neurocognitive indicators composed by BLS, Phototest and DRS-T (model 1); all scales of DRS (model 2); indicators of executive functions, assessed by DRS-IP, FAB and TMT-B (model 3); performance in the verbal and visual-spatial memory subtests – DRS-M, ROCF Memory and Phototest (model 4); performance in visuo-graphical reproduction – DRS-Const, ROCF Reproduction and TMT-A (model 5); the assessment of mood and personality – BDI and BLS Personality (model 6) and a final model (model 7) in which all the significant variables detected in the previous models were included.

Statistical analyses were performed using the statistical package SPSS v.24 (IBM, New York, USA). For all tests, the significance level was set at $p < .05$.

Ethical Considerations

The study was approved by the Ethics Committee of the University of Évora (ref: 12271), welcomed by the Research Unit of the Comprehensive Health Research Center and followed the Declaration of Helsinki. All participants provided signed informed consent.

Results

Of the 157 participants in this study, 107 were women and 50 men, with an average age of 73.6 years old (60 to 90 years) and a school level below the 6th year (5.8 ± 3.2). Seventy-two of the subjects reported a family history of neuro-degenerative disorders with impaired memory.

As illustrated in Table 1, overall, the i-ADL, verbal and visuospatial memory and executive functions were the variables with greater clinical deficit. Performance in the Phototest was above the cutoff score for this test. The most defective scales of the DRS were DRS-M, . DRS-Const and DRS-A were above the cutoff. The visual-graphic reproduction and the visual-spatial memory evaluated by the ROCF presented low values, manifesting clinical impairment. The time taken to perform TMT-A was above the cutoff, revealing a deficit. On average, participants had BDI scores that indicate mild depression.

In b-ADL, 41 subjects were considered dependent and 116 independent, whereas in i-ADL, 123 individuals were considered dependent and 34 independent. In Table 2, we can observe that the scores on the BLS, ROCF Memory and TMT-A were statistically different between the groups classified as dependent or independent, according to the b-ADL. Regarding the i-ADL, we found that the scores in BLS, Phototest, DRS-IP, DRS-C, DRS-

Table 1. Scores for activities of daily living (ADL) and clinical assessment of participants with mild cognitive impairment (MCI).

	Mean (SD)	Cutoff
b-ADL Katz Index (6/24)	6.42 (0.96)	6
i-ADL Lawton & Brody Scale (8/27)	10.71 (2.61)	8
BLS	3.24 (1.42)	</ = 4
Phototest	32.41 (6.28)	>/ = 28/29
DRS-A (./17)	10.61 (2.70)	>/ = 9
DRS-IP (./17)	9.09 (3.14)	>/ = 9
DRS-Const (./17)	11.78 (3.12)	>/ = 9
DRS-C (./17)	9.37 (2.63)	>/ = 9
DRS-M (./17)	6.68 (3.82)	>/ = 9
DRS-T (./17)	8.29 (3.23)	>/ = 9
ROCF Reproduction (./ 36)	25.68 (5.90)	–
ROCF Memory (./ 36)	9.14 (6.46)	–
FAB (./18)	12.11 (2.66)	>/ = 16
TMT-A Time (s)	94.40 (58.47)	–
TMT-B Time (s)	188.03 (70.14)	–
BDI (./63)	16.42 (8.96)	< 13

BLS: Blessed Rating Scales; DRS-A: Dementia Rating Scale Attention; DRS-IP: Dementia Rating Scale Initiation/Perseveration; DRS-Const: Dementia Rating Scale Construction; DRS-C: Dementia Rating Scale Conceptualization; DRS-M: Dementia Rating Scale Memory; DRS-T: Dementia Rating Scale Total; ROCF: Rey–Osterrieth Complex Figure; FAB: Frontal Assessment Battery; TMT: Trail Making Test; BDI: Beck Depression Inventory, Second Edition; SD: standard deviation. b-ADL Katz Index; i-ADL Lawton & Brody Scale; BLS, TMT-A; TMT-B; BDI: higher scores indicate more severe impairment or symptoms. Phototest; DRS (-A, -IP, -Const, -C, -M, -T); ROCF (Reproduction, Memory); FAB: higher scores indicate better performance.

Table 2. Clinical characteristics by level of dependence of participants with mild cognitive impairment (MCI).

	b-ADL Katz Index			i-ADL Lawton & Brody Scale		
	Dependent Mean (SD) n = 41	Independent Mean (SD) n = 116	*P value*	Dependent Mean (SD) n = 123	Independent Mean (SD) n = 34	*P value*
BLS	4.50 (1.35)	2.79 (1.16)	<0.001	3.61 (1.33)	1.90 (0.78)	<0.001
Phototest	31.12 (6.02)	32.87 (6.33)	0.126	31.33 (6.04)	36.32 (5.59)	<0.001
DRS-A	10.61 (2.97)	10.61 (2.61)	0.996	10.61 (2.76)	10.62 (2.52)	0.988
DRS-IP	8.85 (3.21)	9.18 (3.12)	0.567	8.82 (3.12)	10.09 (3.04)	0.037
DRS-Const	11.68 (3.78)	11.82 (2.87)	0.835	11.80 (3.43)	11.71 (1.59)	0.811
DRS-C	9.39 (2.92)	9.36 (2.54)	0.953	9.07 (2.62)	10.44 (2.41)	0.007
DRS-M	6.41 (3.63)	6.78 (3.90)	0.605	6.11 (3.70)	8.76 (3.58)	<0.001
DRS-T	7.90 (2.95)	8.42 (3.33)	0.377	7.76 (3.03)	10.21 (3.25)	<0.001
ROCF Reproduction	24.69 (5.88)	26.02 (5.90)	0.247	24.80 (6.08)	28.66 (4.08)	0.001
ROCF Memory	7.11 (5.95)	9.73 (6.55)	0.036	8.01 (6.29)	12.59 (5.95)	<0.001
FAB	11.56 (2.76)	12.30 (2.61)	0.126	11.61 (2,63)	13.91 (1.93)	<0.001
TMT-A Time	121.08 (78.89)	85.10 (46.39)	0.011	103.08 (61.46)	61.94 (27.94)	<0.001
TMT-B Time	185.15 (64.08)	188.86 (72.11)	0.814	194.41 (70.87)	167.96 (64.95)	0.082
BDI	17.00 (8.01)	16.24 (9.27)	0.663	16.46 (9.06)	16.29 (8.77)	0.924

P-value of Paired-samples T-Test. BLS: Blessed Rating Scales; DRS-A: Dementia Rating Scale Attention; DRS-IP: Dementia Rating Scale Initiation/Perseveration; DRS-Const: Dementia Rating Scale Construction; DRS-C: Dementia Rating Scale Conceptualization; DRS-M: Dementia Rating Scale Memory; DRS-T: Dementia Rating Scale Total; ROCF: Rey–Osterrieth Complex Figure; FAB: Frontal Assessment Battery; TMT: Trail Making Test; BDI: Beck Depression Inventory, Second Edition; SD: standard deviation. b-ADL Katz Index; i-ADL Lawton & Brody Scale; BLS, TMT-A; TMT-B; BDI: higher scores indicate more severe impairment or symptoms. Phototest; DRS (-A, -IP, Const, -C, -M, -T); ROCF (Reproduction, Memory); FAB: higher scores indicate better performance.

M, DRS-T, visuo-graphic reproduction and visuospatial memory (ROCF), FAB and TMT-A were higher (p < .05) in the independent group in comparison with the dependent group.

Table 3 shows the association between scores on b- and i-ADL and on the other neurospsychological variables. The results reveal that people with higher values on b-ADL had higher scores on BLS and TMT-A (p< .01) and worse performance on Phototest, reproduction of ROCF and FAB ($p < .05$). On the other hand, people with higher values on i-ADL had higher scores on BLS and TMT-A and worse results on Phototest, DRS-IP, DRS-M, DRS-T, ROCF Reproduction, ROCF Memory and FAB ($p < .01$). Also, people with higher values on i-ADL had worse results on DRS-C ($p < .05$).

The results of the multivariate analysis (backward method) are shown in Tables 4 and 5. In both cases, multiple linear regression was used to verify whether the independent (quantitative) variables described in each model can predict the dependent variable b-ADL or i-ADL. Five models were statistically significant for the b-ADL: Model 1 containing general neurocognitive indicators (F (1.155) = 77.117; $p < .001$; R2 = 0.332); model 3, performance in executive functions (F (2.113) = 4.243; $p = .017$; R2 = 0.070); model 5, visuographic reproduction (F (1.130) = 10.993; $p = .001$; R2 = 0.078); model 6, mood and personality (F (1.142) = 9.103; $p = .003$; R2 = 0.060) and model 7, significant variables detected in the previous models (F (4.142) = 26.627; $p < .001$; R2 = 0.429).

For the i-ADL, seven models were statistically significant: Model 1 (F (2, 154) = 70.277; $p < .001$; R2 = 0.477); model 2 (F (2.154) = 9.406; $p < .001$; R2 = 0.109); model 3 (F (3.143) = 15.721; $p < .001$; R2 = 0.248); model 4 (F (2,137) = 14.099; $p < .001$; R2 = 0.171); model 5 (F (1,130) = 28.017; $p < .001$; R2 = 0.177); model 6 (F (1.142) = 22.200; $p < .001$; R2 = 0.135) and model 7 (F (4.99) = 28.482; $p < .001$; R2 = 0.535). The variables described above contributed to each model.

Table 3. Pearson's correlation between the neuropsychological variables and the basic activities of daily living (b-ADL) and instrumental activities of daily living (i-ADL) scores.

	b-ADL Katz Index	i-ADL Lawton & Brody Scale
BLS	0.576**	0.668**
Phototest	−0.179*	−0.392**
DRS-A	0.039	−0.022
DRS-IP	−0.043	−0.255**
DRS-Const	−0.108	0.014
DRS-C	−0.117	−0.177*
DRS-M	−0.051	−0.292**
DRS-T	−0.109	−0.350**
ROCF Reproduction	−0.181*	−0.319**
ROCF Memory	−0.130	−0.360**
FAB	−0.168*	−0.384**
TMT-A Time	0.293**	0.410**
TMT-B Time	0.143	0.163
BDI	0.075	−0.022

* p < 0.050; ** p < 0.010; BLS: Blessed Rating Scales; DRS-A: Dementia Rating Scale Attention; DRS-IP: Dementia Rating Scale Initiation/Perseveration; DRS-Const: Dementia Rating Scale Construction; DRS-C: Dementia Rating Scale Conceptualization; DRS-M: Dementia Rating Scale Memory; DRS-T: Dementia Rating Scale Total; ROCF: Rey–Osterrieth Complex Figure; FAB: Frontal Assessment Battery; TMT: Trail Making Test; BDI: Beck Depression Inventory, Second Edition.

Table 4. Multiple linear regression (backward stepwise) of neuropsychological function as a predictor for daily functioning basic activities of daily living (b-ADL).

		Beta	*t*	*P value*	R^2
Model 1	BLS	0.576	8.782	<0.001	0.332
Model 3	FAB	−0.317	−2.781	0.006	0.070
	FAB Flexibility	0.270	2.370	0.019	
Model 5	TMT-A	0.279	3.316	0.001	0.078
Model 6	BLS Personality	0.245	3.017	0.003	0 .060
Model 7	BLS	0.815	8.598	<0.001	0.429
	FAB Flexibility	0.128	1.862	0.065	
	TMT-A	0.162	2.300	0.023	
	BLS Personality	−0.400	−4.276	<0.001	

BLS: Blessed Rating Scales; FAB: Frontal Assessment Battery; TMT: Trail Making Test.

Discussion

This study relates different neuropsychological functions to everyday functioning assessed by the b-ADL Katz Index and the i-ADL Lawton & Brody Scale, in people with MCI. Furthermore, the present study also predicts how these mental functions contribute to the variation of b- and i-ADL performance.

Our results are aligned with the literature, which refers to i-ADL as more sensitive than the b-ADL to the effects of mental decline (Cornelis et al., 2019; Jekel et al., 2015; Pérès et al., 2008; Perneczky et al., 2006; Reppermund et al., 2013, 2011; Schmitter-Edgecombe et al., 2012). In fact, 73.9% of participants showed independence in b-ADL, while these results dropped to 21.7% in i-ADL. The correlations between everyday functioning and neuropsychological had less significant associations and less intensity for b-ADL compared to i-ADL. However, TMT-A (attention, visual perception, speed of visual-motor speed, and information processing) and BLS (functional and emotional changes) were positively associated with b-ADL. Also, Phototest (screening test), ROCF Reproduction (perceptual

Table 5. Multiple linear regression (backward stepwise) of neuropsychological function as a predictor for daily functioning instrumental activities of daily living (i-ADL).

		Beta	*t*	*P value*	R^2
Model 1	BLS	0.619	10.222	<0.001	0 .477
	DRS-T	−0.183	−3.017	0.003	
Model 2	DRS-IP	−0.167	−2.021	0.045	0 .109
	DRS-M	−0.227	−2.752	0.007	
Model 3	DRS-IP	−0.220	−2.961	0.004	0 .248
	FAB	−0.193	−2.237	0.027	
	TMT-B	0.261	3.008	0.003	
Model 4	ROCF Memory	−0.262	−3.035	0.003	0,171
	Phototest	−0.224	−2.595	0.010	
Model 5	TMT-A	0.421	5.293	<0.001	0,177
Model 6	BLS Personality	0.368	4.712	<0.001	0.135
Model 7	BLS	0.779	7.317	<0.001	0.535
	DRS-IP	−0.167	−2.432	0.017	
	TMT-A	0.203	2.869	0.005	
	BLS Personality	−0.234	−2.244	0.027	

BLS: Blessed Rating Scales; DRS-T: Dementia Rating Scale Total; DRS-IP: Dementia Rating Scale Initiation/Perseveration; DRS-M: Dementia Rating Scale Memory; FAB: Frontal Assessment Battery; TMT: Trail Making Test; ROCF: Rey–Osterrieth Complex Figure.

activity) and FAB (executive function), where higher scores indicate better performance, were negatively related to b-ADL. For the more complex i-ADL, the associations with neuropsychological measures were more intense. Significant and positive associations were found between i-ADL and functional and emotional changes and attention, where higher scores indicate more severe impairment. The performance in general neurocognitive indicators, in tests that assess verbal and visuo-spatial memory, executive functions and visuo-graphic reproduction, were negatively associated with i-ADL. Attention, construction, ability to switch between sequences or mood did not seem to have any relationship with i-ADL.

In the present study, the subdomains of i-ADL with the most deficits were responsibility for own medication, shopping and preparing meals, which represent activities that appeal to cognitive abilities such as executive functions, mental flexibility, sensitivity to interference, inhibitory control and information processing, as well as verbal and visuospatial memory. Overall, these findings are in accordance with previous studies (Amanzio et al., 2018; Perneczky et al., 2006; Reppermund et al., 2013, 2011; Schmitter-Edgecombe et al., 2012). We also found two studies (Mariani et al., 2008; Pedrosa et al., 2010) showing that there is a significant impairment in handling economy in people with MCI, which was not confirmed in the present study. According to the literature, subjects with higher executive dysfunctions tend to have more limitations in i-ADL (Cornelis et al., 2017, 2019). Verbal and visuospatial memory difficulty has been also associated with increase in i-ADL difficulty (Cordier, Chen, Clemson, Byles, & Mahoney, 2019; Cornoldi et al., 2007). On the other hand, it was found that having more difficulties in i-ADL, especially in those tasks with higher cognitive demand, was associated with overall cognitive functioning (Reppermund et al., 2011). These findings have implications for the diagnostic determination of MCI, suggesting that the difficulties in everyday tasks are more likely observed in activities with higher cognitive demand, especially those involving executive functions and memory.

The multivariate analysis carried out in this study showed that difficulties in functional and emotional changes explain 33.2% of the variation in b-ADL. This variation rises to

42.9% when BLS is associated with lexical fluency test, TMT-A and BLS Personality. All other models computed by linear regression analysis proved little ability to predict b-ADL. On the other hand, models 2 and 4, which included the DRS scales and the memory assessment tests, did not present any predictive value. Regarding the i-ADL, we found that models 1 and 7 were the most predictive. A general neurocognitive tests explained 47.7% of the variation in i-ADL, and a group of significant variables detected in the previous models as BLS, DRS-IP, TMT-A and BLS Personality explained 53.5% of this variation. The model that includes the variables measuring executive functions explained 24.8% of the variation in i-ADL. All other models proved to be more limited to predict dependence in i-ADL. In the present study, was found a modest result of 10.9% of the different scales of DRS to predict i-ADL. Our results did not confirm previous investigations that the DRS scores predicted functional decline, showing good clinical validity to detect and classify the severity of cognitive and functional impairment (Katsarou et al., 2010; Woolf et al., 2016).

When we consider the final statistical models, the BLS and TMT-A were the most significant predictors of everyday functioning, assessed by b- and i-ADL. However, when we focus on i-ADL, other indicators seemed to be relevant, such as DRS-IP, DRS-T, DRS-M, FAB, TMT-B, ROCF Memory and Phototest. These results agree with previous findings suggesting the importance of considering the executive functions to predict i-ADL (Cornelis et al., 2019). We also found that memory is important to predict daily activities, which is not in line with previous studies (Amanzio et al., 2018). Recognition memory tasks, assessed by DRS, show interference from other intermediate tasks (Pedraza et al., 2010). Visuo-spatial memory, evaluated by the ROCF, is a highly complex task (Cruz et al., 2011). These results confirm that activities with higher cognitive demands have a higher predictive value for i-ADL. These are domains that may support the selection of techniques for preventing decline and intervention in MCI.

It is important to note that this study includes a sample size which is larger than other similar studies, and the administration of a wide neuropsychological assessment battery. Nevertheless, the present study also included limitations that require further discussion. First, we should mention that the addition of other groups of the population (e.g., AD, or without cognitive impairment) could strengthen the analysis of the association between the clinical neuropsychological assessment and functional decline. Second, to enrich the analysis and verify the predictive power of neurocognitive variables in the face of more complex tasks, it would be interesting to use in the future a scale of advanced ADL. Finally, a future study should better control factors that may influence cognitive functioning, such as comorbidities, vitamin deficiencies, and drugs.

Conclusion

Our results suggest that there is an association between performance on several neurocognitive variables and daily functioning in people with MCI, especially in i-ADL. However, it is recommended to use BLS, DRS-IP, DRS-T, DRS-M, FAB, TMT-A, TMT-B, ROCF Memory, and Phototest to predict activities that require more complex cognitive processes such as i-ADL. The global indicators of clinical evaluation and those that assess executive functions and verbal and visuospatial memory seem to contribute strongly to predict the instrumental functioning of everyday life. These results point to the need for interventions focused on executive functions and memory decline to prevent decrements in the performance of tasks in everyday functioning.

Disclosure Statement

Each author signed a form for disclosure of potential conflicts of interest. No authors reported any financial or other conflicts of interest in relation to the work described.

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ORCID

Rogério Paulo dos Santos Henriques http://orcid.org/0000-0002-8125-8307
José Francisco Filipe Marmeleira http://orcid.org/0000-0002-5534-9600

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, [R H], upon reasonable request. Please contact https://www.uevora.pr.

Ethical Principles

The authors affirm having followed professional ethical guidelines in preparing this work. These guidelines include obtaining informed consent from human participants, maintaining ethical treatment and respect for the rights of human or animal participants, and ensuring the privacy of participants and their data, such as ensuring that individual participants cannot be identified in reported results or from publicly available original or archival data.

Role of the Funders/Sponsors

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