Validation of the 80Plus Battery in the Oldest-Old

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Abstract. Population aging has led to a growing need for accurate cognitive assessment tools tailored to the oldest-old (80+ years). This study evaluates the 80Plus battery, a chronometric tool designed to assess executive functions (working memory and inhibition) in this population. Thirty community-dwelling older adults (80–90 years) completed the 80Plus tasks, the Montreal Cognitive Assessment (MoCA), and the Dysexecutive Questionnaire (DEX-Sp). Results showed that while MoCA scores moderately predicted age-related decline, when combined with the 80Plus battery together they explained over 70% of the variance in age. Accuracy and reaction time scores in 80Plus tasks showed strong associations with MoCA but not with self-reported dysexecutive symptoms. The DEX-Sp did not correlate with age or cognitive performance, highlighting its limited utility in the oldest-old. These findings underscore the added value of combining classical and chronometric assessments. The 80Plus battery provides a sensitive, ecologically valid tool for detecting executive decline in very-old adults, complementing traditional instruments and supporting earlier, more accurate intervention strategies.

Keywords: Executive Functions · Oldest-old · Cognitive Assessment · MoCA · 80Plus Battery · Impulso Cognitivo

1 Introduction

Population aging is a phenomenon that is becoming increasingly prevalent worldwide. The United Nations [1] estimates that by 2050, there will be twice as many older people as children under the age of 5, a trend observed in practically every country, along with a notable increase in the population aged over 80. In Europe, this transformation has also become evident. According to recent data from Eurostat [2], the proportion of older people grew by 21% between 2001 and 2023. Specifically, the over-80 age group (often termed the oldest-old) almost doubled, increasing from 3.4% to 6% of the total population. This growth is largely due to improvements in living conditions and healthcare for older adults.

Given this global reality, it is urgent to prioritize strategies aimed at promoting cognitive health and preventing the deterioration associated with aging, which can already manifest at relatively early stages [3]. As the proportion of the older adult population

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increases, so does the prevalence of age-related diseases. It is essential to conduct cognitive assessments at the earliest stages of decline to design effective interventions [4]. Importantly, cognitive decline increases the risk of dependency in daily activities, thereby negatively impacting the quality of life of the oldest-old population group [5].

Over time, numerous studies have demonstrated the effectiveness of cognitive assessments and interventions in strengthening general cognitive abilities, particularly those related to executive functions (EF) in older adults [6–8]. Neurodegeneration affects these essential functions, which include planning, behavioural control, decision-making, and emotional regulation that are crucial for achieving effective and socially appropriate behaviour [9, 10]. The assessment of EF in older adults, and particularly in the oldest-old, poses specific challenges due to the limitations of classical paper-and-pencil tools. Originally developed for younger populations, these tests often lack the sensitivity to detect subtle executive changes at this late stage of aging, hindering the distinction between normal and pathological decline. Furthermore, EF tend to cluster with age [11], and older adults often exhibit reduced awareness of executive deficits, leading to underreporting on self-assessments. This, together with the high interindividual variability and ceiling/floor effects found in some accuracy-based tasks [12, 13], calls for new integrative assessment protocols capable of adequately capturing the inherent variability in EF, and as a consequence, in cognitive decline, in the oldest-old. There is a clear need to develop more sensitive and accurate tools that can distinguish between normal aging effects and early signs of neurodegenerative disorders [14]. Such tools should be tailored to the target population, brief and easy to administer, useful in different contexts, sensitive to changes over time, and demonstrate adequate validity and reliability [15].

Impulso Cognitivo [16] has developed the 80Plus executive function assessment battery, a tool specifically designed to assess two critical components of EF (namely, working memory and inhibition skills, as markers of cognitive control) in the oldest-old population. This battery, aimed at adults over 80 years of age, offers both precision and chronometric measures obtained from well-known laboratory tasks, in an environment and response format accessible to the target population, thus surpassing the limitations of traditional cognitive tests. The objective of the current study is to validate this tool by comparing it with the MoCA test (Montreal Cognitive Assessment), a widely recognized, brief, and effective instrument for detecting cognitive impairment. The MoCA is known for its validity and reliability, making it a highly valuable tool for obtaining information about general cognitive status. Additionally, the MoCA is noted for its high sensitivity to cognitive impairment and the resulting deficits in executive functions [17]. However, several studies have highlighted its limitations when applied to adults over 80 years old, given that conventional thresholds have been proven to be unreliable in this population [18, 19]. Additionally, we explored the extent to which the 80Plus chronometric battery would offer further information about executive functioning in this population over and above an existing paper-and-pencil assessment tool showing good psychometric properties in younger samples: the Dysexecutive Questionnaire [20]. Our hypothesis was that a combined chronometric and classical approach would be better suited for assessing age-related cognitive decline in the oldest-old than relying solely on self-report measures.

2 Methodology

2.1 Participants

Thirty community-dwelling Spanish-speaking older adults took part in the study. All were between 80 and 90 years of age (M = 84.7, SD = 3.7; range = 80–90) and lived independently in the community or with family members. Of these participants, 21 were women and 9 were men. Participants were recruited through senior-citizen associations and daycare centres in three Spanish autonomous communities. Inclusion criteria required preserved activities of daily living, normal or corrected-to-normal vision and hearing, and the ability to give informed consent. Individuals with a history of neurological disorder, major psychiatric illness, or uncontrolled systemic disease were excluded. Sex was recorded as part of the socio-demographic questionnaire. All participants completed the full cognitive assessment battery described below and received verbal feedback and a written summary of their individual results. The average duration of the assessment session was approximately one hour. Throughout the process, a trained psychologist was present to provide instructions, ensure participant comfort, and offer support when needed. All procedures conformed to the Declaration of Helsinki.

2.2 Instruments

Three tools were used: the Spanish version of the Montreal Cognitive Assessment (MoCA), the Spanish adaptation of the Dysexecutive Questionnaire (DEX-Sp), and the 80Plus battery developed by Impulso Cognitivo S.L. The study was conducted independently from the developing company, and no conflict of interest exists.

The MoCA is a widely used instrument designed to identify possible mild cognitive impairment. It assesses various cognitive abilities, including attention, concentration, executive functions, memory, language, visuospatial skills, calculation, and orientation [17]. The Montreal Cognitive Assessment (MoCA) yields a total score ranging from 0 to 30, with higher scores indicating better cognitive performance. A score of 26 or above is commonly considered within the normal range, although optimal cut-off values may vary depending on demographic and clinical factors.

The Dysexecutive Questionnaire, Spanish version (DEX-Sp) is based on the original DEX [21], adapted into Spanish [22]. It comprises 20 items assessing everyday behaviours, covering emotional, motivational, behavioural, and cognitive facets of executive dysfunction. Items are rated on a 0–4 Likert scale and summed (0–80), with higher scores indicating greater dysexecutive symptomatology.

The 80Plus executive function assessment battery is a chronometric tool purpose-built to assess cognitive skills related to executive functions in people aged 80 years or older. It consists of 4 tasks presented in a game format on a tablet. These tasks are based on classic paradigms but adapted to overcome the limitations of traditional tests for this population group, requiring single (e.g., go/no-go) responses instead of traditional binary choices (e.g., yes/no). The first task is based on traditional chronometric go/no-go tasks [23], and it evaluates executive functions related to inhibitory control, cognitive flexibility, working memory, and reaction time by asking participants to tap the screen only when a given target appears, withholding responses when distractor items

are displayed. In Task 2, combining elements from the Attention Network Test (ANT) [24] and Simon paradigm [25], participants tap the screen when the target element is facing one direction (i.e., right), and must refrain from responding when it is oriented in the opposite direction (i.e., left). The third task, inspired by the classic antisaccade task [26], is designed to measure inhibitory control and the ability to suppress automatic responses to external stimuli. Participants are instructed to tap on the screen only when the target element appears in a given quadrant, ignoring a previous mismatching visual cue presented in an opposite quadrant. Finally, the fourth task, based on the classic N-Back paradigm [27], presents participants with a 1-back version that taxes working memory by requiring them to compare each stimulus with the one immediately preceding it, and tapping on the screen only when the displayed element is identical to the one shown in the previous trial.

3 Results

A series of descriptive, bivariate correlations and regression analyses were carried out to ascertain the extent to which the 80Plus battery could provide additional information regarding executive functioning in the oldest-old as compared to traditional paper-and-pencil tests. To this end, the chronometric (reaction time, RT) and accuracy data in the critical trial block (i.e., go-trials) in each of the tasks of the battery were obtained after careful inspection for and deletion of outlier responses. Those values were averaged and used as the two dependent variables corresponding to the 80Plus battery. As shown in Fig. 1 (upper panel), results showed a variable pattern with wide distributions of the main variables.

Bivariate Associations. As shown in Fig. 1, lower panels, age showed a moderate, statistically significant negative correlation with global cognition as measured by the MoCA ($r = -.566$, $p = .001$). The accuracy in the 80Plus battery declined with age ($r = -.613$, $p < .001$) and increased with MoCA performance ($r = .729$, $p < .001$), whereas reaction-time-based 80Plus scores demonstrated a non-significant trend toward slower responses with greater age ($r = .306$, $p = .100$) and significant faster responses with higher MoCA scores ($r = -.426$, $p = .019$). Interestingly, the DEX-Sp did not correlate with Age, MoCA, or any metric obtained from the 80Plus battery (all $|r| < .17$, $p > .35$), suggesting limited convergent validity between self-reported dysexecutive symptoms and objective or global cognitive indices in this highly aged sample (Fig. 2).

Hierarchical Linear Regression Predicting Age. Model 1 included only MoCA scores, and they emerged as a significant predictor ($\beta = -0.37$, $p = .01$). The model explained 24.7% of the variance in chronological age ($F(1, 24) = 7.89$, $p = .01$). Model 2 added the DEX-Sp scores, and the results showed that the model was not statistically better at predicting the age as compared to Model 1 that only included the MoCA ($R^2 = .253$; Model 2 – Model 1 contrast: $F(1, 23) = .13$, $p > .70$), thus showing the limited predictive power of the DEX-Sp in the oldest-old. In contrast, when the RT and Accuracy scores in each of the four tasks of the 80Plus battery were included (Model 3), this augmented significant model accounted for 71.5% of the variance ($F(10, 15) = 3.77$, $p = .01$), yielding a significant increment in explained variance ($\Delta R^2 = .464$, F-change =

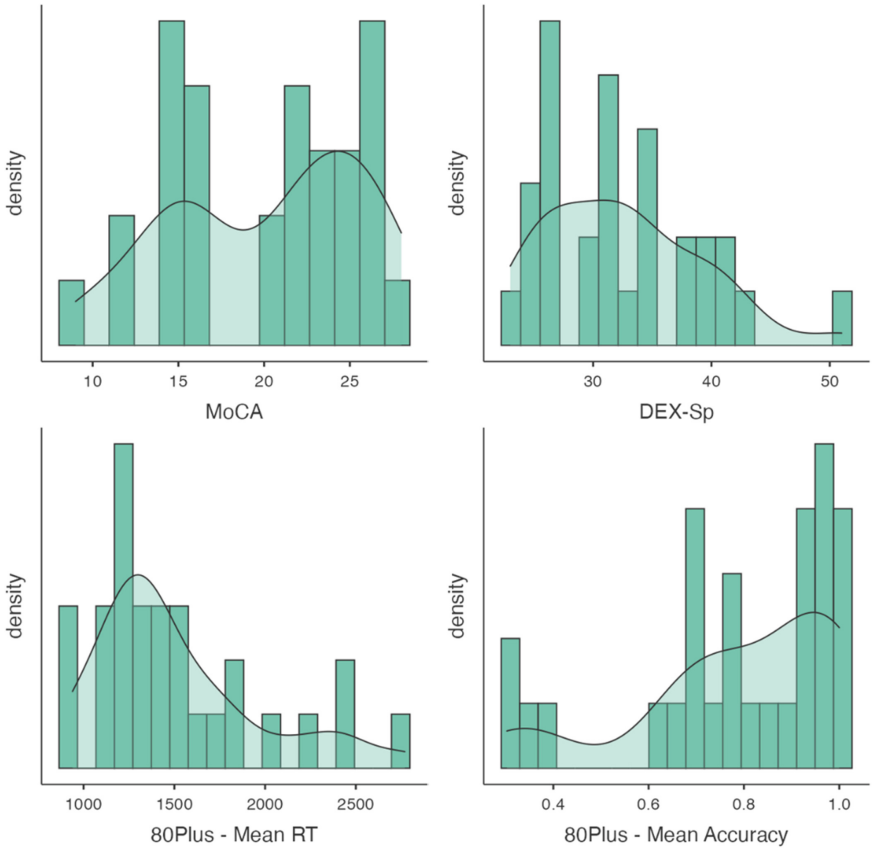


Fig. 1. Density distributions of the MoCA and DEX-Sp scores, together with the mean RT (in milliseconds) and mean accuracy (in percentage of hits) across tasks in the 80Plus battery.

3.06, p = .03), underscoring the added explanatory power of chronometric task-based executive measures.

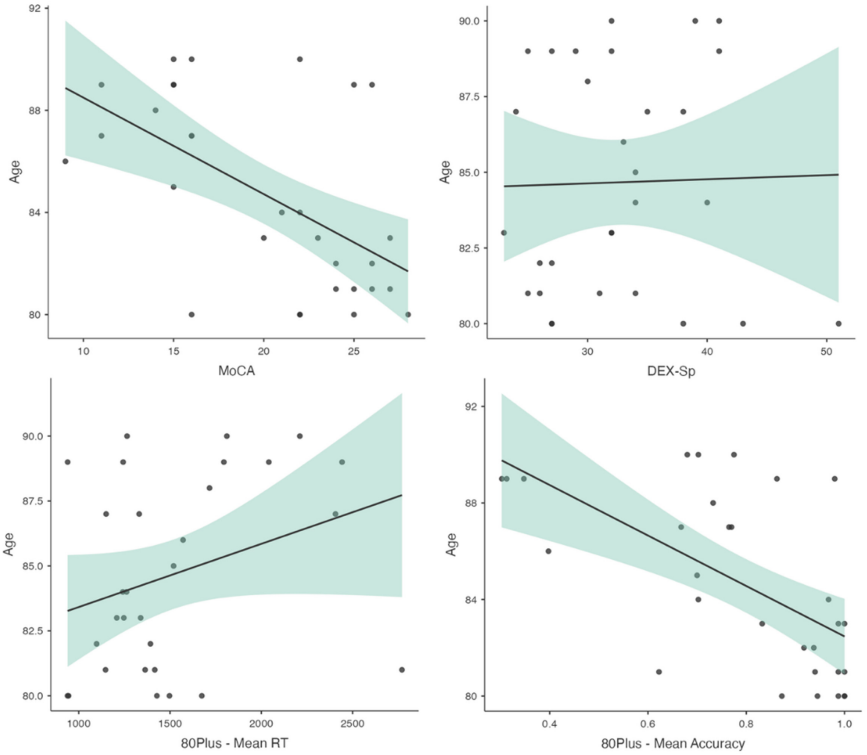


Fig. 2. Density Dispersion graphs with linear regression lines and standard errors of each measure and Age.

4 Discussion

Collectively, these findings indicate that while global cognition (MoCA) reliably tracks age-related decline in very-old adults, fine-grained experimental indices of executive control provide substantial additional leverage in modelling age differences, whereas self-report measures of dysexecutive behaviour appear uninformative in this context.

The results of this study highlight the remarkable explanatory power of the 80Plus battery in capturing executive function variability among the oldest-old. By incorporating chronometric measures such as reaction time and accuracy across well-established cognitive paradigms, the 80Plus battery accounted for over 70% of the variance in age-related cognitive performance when combined with the MoCA. This high level of explained variance underscores the battery's sensitivity and precision in detecting subtle executive changes that traditional tools often overlook. Its design, tailored specifically for individuals aged 80 and above, allows for a more nuanced and ecologically valid assessment of cognitive.

In contrast, the Dysexecutive Questionnaire (DEX-Sp), a widely used self-report tool, demonstrated limited utility in this context. The absence of significant correlations

between DEX-Sp scores and both objective cognitive measures and age suggests that self-perceived executive dysfunction may not reliably reflect actual cognitive performance in the oldest-old.

Although the MoCA remains a gold-standard screening tool for general cognitive impairment, its capacity to capture the full spectrum of EF decline in the oldest-old appears limited. While it significantly predicted age-related decline, it explained only a modest portion of the variance compared to the 80Plus battery. This suggests that while MoCA is useful for broad cognitive screening, it lacks the granularity needed to detect specific executive deficits in this age group. In addition to healthy individuals over eighty, the 80Plus battery may be applicable in clinical settings, including elderly patients with neurological conditions. Therefore, combining the MoCA with the 80Plus battery offers a more comprehensive and accurate approach to cognitive assessment in the oldest-old, enhancing both diagnostic precision and intervention planning.

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