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AGING AND FUNCTIONAL COMPLEX ACTIVITIES: CLINICAL AND SOCIAL PERSPECTIVES

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Abstract

Background: Several papers describe functional changes in the aging population, and its relevance in early detection.

Objectives: In order to count on a tool to evaluate the performance in the use of new technologies we have designed a new protocol - Complex Functional Study (CFS)-that quantifies performance and functional changes related to previous states.
Our objectives are to study the aging population with this lately developed tool.
Methods: We evaluated 350 healthy subjects grouped according to age and instruction levels. We administered a General Cognitive Screening and the CFS. We used ANOVA Test, and Regression Analysis and Principal Components.
Results: Our finding verifies that the 15.75% registered functional loss and the 2.8%, registered changes in performance. The differences in the averages were higher at the age range 80-90. The measure of change proved to have less impact in groups with higher instruction level. A greater functional loss has been registered in older participants with less instruction level.
Conclusions: This study enables the use of the CFS as a tool of clinical interest for the detection of incipient impairment in daily living complex functional skills.
The results obtained verify a good performance in those skills in most of the studied population. On the other hand, this study has also a psycho-social perspective insofar as it fosters significant learning processes. In this way it will be possible to implement strategies to develop social awareness about the learning capacity in the elderly to impact in the social net and on their wellbeing.

Keywords
Aging, Complex functionality, Change, Losses, Profiles, Screening.

1. Introduction

The functional capacity is defined as a set/group of abilities which allow us to live and perform our daily activities with autonomy /autonomously (Brooks & Loewenstein, 2010). We can differentiate two groups of functional performances, basic daily activities such as getting dressed, bathing, moving around, traditionally evaluated with the Katz (Katz, Ford, Moskowitz et al., 1963) index and instrumental daily activities developed by Lawton et al. (Lawton & Brody, 1969) assesses activities performed by means of a tool/device, such as taking medication, preparing food, cleaning, household chores, money management and using means of transport among others. These scales' structures register the state of the art of the function at clinical consultation time, in reference to autonomy, frequency or/and assistance help/requirement.

Johnson et al. (Johnson, Barion, Rademaker, Rehkemper, & Weintraub, 2004) elaborated the ADLQ (Activity Daily Living Questionnaire), which evaluates six areas of activities: Personal care, house management, work and leisure, shopping and money management, moving and communication.

Various articles describe a change and decline in these functions related to the aging process which are often associated with a high risk of subsequent health decline. (Colón-Emeric , Whitson, Pavon , Hoenig ,2013; Farias, et al, 2013).

Recent research refer that Instrumental ADLs are more complex everyday tasks, such as preparing a meal, managing finances or shopping would constitute a good predictor of dementia 10 years prior to its diagnose as its supposed to aid in an early detection of incipient dementia (Reppermund ,Brodaty, Crawford, 2013; Brown, 2011; Beck, Kędziora-Kornatowska, 2013; Binegar, Hynan, Lacritz, Weiner & Cullum, 2009).

Lassen-Greene et al.,(2017) showed that individuals with Mild Cognitive Impairment (MCI) compared to cognitively normal peers performed worse on speed and accuracy on instrumental activities of daily measures of IADLs and concluded that performance on measures of IADL are valuable indices for early detection of functional change in MCI.

A specific pattern of functional losses, beginning with impaired performance of ADL, followed by losses in complex activities of daily living is associated with cognitive decline (Dias, Andrade, Oliveira, Ferreira & Lebrão, 2015).

Performance would be connected to mental processes related to age impact cognitive functioning, mainly executive functions in charge of controlling mechanisms which modulate several cognitive sub processes that regulate human cognition dynamics. Executive functions may be particularly relevant to ADL capacity, given their role in the formulation of plans, monitoring of their implementation, and changing to new plans organization. These functions are important to perform simple and complex tasks in everyday life. (Mograbi, Faria, Charchat Fichman, Paradela & Lourenco, 2014)

On the other hand, functional changes impact on life quality in healthy adults as well as in those who present a subjective cognitive decline (Pusswald et al, 2015).

All research done in populations with neurological pathologies shows that executive dysfunction is related to poor functional status affecting life quality. Executive deficit is considered as a common symptom in aging people with MCI and might predict future dementia disease. (Reinvang, Grambaite & Espeseth, 2012; Bangen et al., 2010; Foster Hershey, 2011).

Functional changes are currently assessed in combination with genetic, neurobiological, neuroimages and cognitive behavioral indicators as one of the risk factors in dementia (Bondi & Smith, 2014; Albert et al. 2011).

A mild decline in daily life complex activities is included as a diagnosis criterium for MCI (Langa & Levine, 2014).

In a current review (Jekel, Damian, Wattmo, Hausner, 2015) complex functional failure was found in a significant number of MCI patients, remarking the need for early detection. They concluded that the development of performance-based assessment instruments should be intensified, as they allow a valid and reliable assessment of subtle IADL deficits in MCI and subline that another important point to consider when designing new scales is the inclusion of technology-associated IADL.

Not only functional deficit but also a great variety of neurological disorders are present in vascular dementia. Nevertheless these are not always assessed in a formal and systematized manner.

In spite of the high development in qualifying scales for functional level in dementia in medical practice progression evaluation turns long and complex because functional evaluation devices are not sensitive enough to measure this effect (Robert et al, 2010). Evidence has increased the use of functional scales to evaluate complex functional status because on clinical assessment it is hard to tell change from expected loss for the age of disease indicators.

We highlight the importance of the functional changes and/or losses that take place due to age and the need to differentiate them from those indicators/ manifestations that evince an abnormal or pathological behavior. In this sense, there are few studies that investigate the complex functional decline in healthy subjects, which makes it difficult to differentiate, at the time of consultation, the expectable changes according to age from those early indicators of disease.

Likewise the relation between cognitive and chronological age has been studied and the significant variables that make an individual have a younger perception of himself have also been researched. An interesting work on a population between ages 65 and 80 was performed to control demographic and psychosocial factors and a correlate was found in connection to this discrepancy (Choi, Di Nitto & Kim, 2014).

They were closely associated to objective conditions of the health level linked to chronic disease. Preservation in basic and complex functional activities would imply a high impact and a fundamental issue on aging population lifestyle, fostering a higher self-esteem and self-motivation promoting therefore more activity.

Heiens & Pleshko (2017) in the recent research introduced a re-conceptualized version of the cognitive age construct, Agecog, that contained five sub dimensions, including feel-age, look-age, act/do-age, interests-age, and think-age. Those who report a younger cognitive age have better social support, income, education, and health.
The aging population who began using the new technologies belong to the so called "The traditionalists", born between 1928 and 1944, and the "baby boomer" generation, born between1945 and 1965 whose learning process took place at least in the last ten years. Therefore it is relevant to assess changes and functional losses related to these new technologies (Cilliers, 2017).

The clinical importance of detecting pathological behaviors in these functions and the lack of assessing tools in our field made it a must to design a register tool to account for performance in complex activities depending on new technologies, such as the PC, the cellphone or some others.

The Complex Functional Scale (CFS) (Labos & Trojanowski, 2013) introduced in this study, consists of a questionnaire which evaluates different functions. It can be administered by health professionals on a clinical consult context.

This scale provides information about the state of complex functional activities in a patient compared to a previous state, complementing in this way not only the diagnostic evaluation but also the progression profile.

This first stage of development of the research is descriptive and transversal. The purpose of this research is to introduce the CFS and to show the results in our context, in a free cognitive impairment aging population made up of men and women. Considering two variables, age and instruction level. Other central aim is to identify a typical profile of change or/and functional loss expected in this population, so as to project a future clinical implementation of this scale. Last but not least estimate the degree of stabilization in the learning of complex functions through time and consider its construct in a psychosocial projection of the aging population.

2. Methods

405 subjects were recruited between 50 and older than 80 years (68.97+ -9.62), 350 participated in this study, out of this number 203 male and 147 female. They were randomly selected according to established inclusion and exclusion criteria; river plate Spanish native speakers, literate, full cognitive integrity with cut point 26 in the MMSE and with a normal performance in ADL and IADL scales. Neurologically or psychiatrically impaired participants were excluded and those with motor or sensorial non compensated deficit too. Recruitment took place between 2014 and 2017 in the administrative offices at UBA, School of Medicine and at the Geriatric Unit in The clinical Medicine Service from Buenos Aires Italian Hospital. Participants were assessed by the physician in charge as part of the initial clinical study with protocol duly approved by the ethical committee. Participants were patients who complained of a cognitive problem and whose formal evaluations showed no deficit. They voluntarily accepted inclusion with an oral informed consent.

2.1 Materials, Design and Procedure

Participants were evaluated with a battery of cognitive and functional screening tests; MIS (Memory impairment Scale) with differed recollection (Labos, Trojanowski, Seinhart, Shapira & Renato, 2015) in order to verify the normal performance in episodic memory, the Folstein Minimental Scale (Folstein, Folstein & McHugh, 1975) and assessment scale of daily activities, ADL (Katz, Ford & Moskowitz, 1963) and IADL (Lawton & Brody, 1969).Those who complied with admission criteria completed the CFS. Tests were administered in just an only one-hour interview.

ANOVA test, Regression Analysis and of the main components test were used so as to get a deeper interpretation of the variables and instrumental assembling.

2.2 Complex Functional Study Scale

CFS structure and procedure: is a questionnaire which evaluates 2 different areas of complex functionality distributed among 5 tasks, 1) Domestic appliances use, microwave and remote control for TV use and 2) Cutting edge technology management, cellphone, PC and ATM use. It considers the learning starting point of the instrument and the number of functions used at that moment (see Annex).This structural characteristic of the test allows for assessment of current performance of the patient in reference to a previous state and at the moment of acquiring the function. It can be self administered without leaving aside that it can also be administered by a family member. Administration time takes approximately 10 minutes.

In every of the explored functions participants are questioned about initial tasks of use, years using the domestic appliance or cutting edge device, best performance achieved at learning time and current performance in reference to tasks done at acquisition time.

With these data two partial scores are obtained for each function, one referred to change in performance and the other connected to the degree of functional loss. Both scores reflect the current functional capacity of the subject.

2.3 Scoring

To estimate the score of loss and/or change we consider the number of tasks the participant performed in relation to the number of task register at assessment time (relation between answers in II and III, see Annex). Those instrumental functions which have not been used or learned will not be considered for assessing.

The final loss score is the addition of the scores of partial losses. The maximum loss score for CFS is fifteen (15) being this the indicator of loss of functionality in all explored functions.

The score of change will be always register with a fix value of 0, 5 or 0 in the case it is not manifested.

The final score of change is the sum of the partial scores being its maximum value 2.5

3. Results

The sample design was stratified having into account the number of years of instruction level: elementary from 3 to 7 years (n=77), intermediate level from 7 to 12 years (n=92) and advance level more than 12 years (n=80), and the age from 15 to 59 years (n=73), 60 to 69 (n=123), 70 to 79 (n=109) and from 80 to 92 (n=45) (Table 1).

Table 1: *Cross Tab for variables Age, Instruction and Gender*

Age	Elementary		Medium		Advanced		Total
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	
50-59	13	18	11	5	10	16	73
60-69	31	25	11	18	13	25	123
70-79	24	44	7	25	4	5	109
80 y +	10	13	10	5	3	4	45
Total	78	100	39	53	30	50	350

Significant differences were obtained in the variances analysis, in measures of change for the variable Age (F value 86.45, Pr (>F<0.001) and Instruction Level (F value 146.5, Pr (>F) <0.001) and loss measure for the Age variable (F value 9.759, Pr (>F) 0.001). Findings showed significant differences in relation to loss score according to age variable in a correlation between age and instruction (Table 2).

Table 2: *Variance Analysis Instruction and Interaction between both for Measure of Change and Functional Loss*

Measure of change	Df	Sum Sq	Mean Sq	F value	Pr(>) F
Age	5	81.06	16.221	86.45	<0.001 ***
Instruction level	3	81.47	27.157	146.5	<0.001 ***
Measure of loss	**Df**	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>) F**
Age	3	66.0	22.001	9.759	<0.001 ***
Instruction level	2	6.0	2.991	1.235	0.081
Measure of change	**Df**	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>) F**
Age	5	81.050	16.21	91.18	<0.001***
Instruction level	2	1.234	0.61	3.46	0.0321*
Age and instruction level	6	63.115	0.61	3.48	0.0023**

The older the participants, the lower the instruction level, the higher the functional loss. In reference to score of change a correlation was manifested where older subjects with a higher instruction level got a higher score of change (Table 3).

Table 3: *Limit of Confidence for Measure of Change and Loss according to Age and Instruction Level*

Levels	Limit of confidence			
	Measure of change		**Measure of loss**	
	2.5 %	**97.5 %**	**2.5 %**	**97.5 %**
(Intercept)	-0,06	2,06	0,81	1,19
Age Group 1	-4,74	4,74	-0,85	0,85
Age Group50-59	0,43	3,57	1,72	2,28
Age Group60-69	1,12	3,85	1,86	2,35
Age Group70-79	1,85	4,52	2,01	2,49
Age Group80 and older	1,41	4,59	1,71	2,29
Advance Instruction Level	-3,11	1,11	-0,38	0,38
Elementary Instruction Level	-0,41	2,68	-0,19	0,37
Age group 50-59: Advanced instruction level	-1,38	3,76	-0,35	0,58
Age group 60-69:Advanced instruction level	-1,17	3,63	-0,53	0,33
Age group 70-79:Advanced instruction level	-2,81	2,66	-0,08	0,91
Age group 50-59:Elementary Instruction level	-2,72	1,48	-0,44	0,32
Age group 60-69:Elementary Instruction level	-3,10	0,65	-0,53	0,14
Age group 70+de 80:Elementary Instruction level	-1,95	1,72	-0,69	-0,03

Out of the total sample, 55 participants register loss (15.75%) and only 10, changes (2.8%). The highest contrasts are manifested in older participants with lower instruction level. 35 correspond to an elementary level, and only 7 to an advanced level. The loss measure for these subjects is 2.44 (DS 2.33). A correlational analysis was performed updated use of the different tasks. A significant correlation was found among variables; for the cellphone 0.75, for TV 0.87, for microwave 0.93, for PC 0.93 and ATM 0.93 (Table 4).

Table 4: *Variables Correlation Matrix*

	Cellphone		TV		Micowave		PC		ATM	
	Time	Use	Time	Use	Time	Use	Time	Use	Time	Use
CEL-TIME	1,0000	0,7562	0,3522	0,3174	0,3240	0,3072	0,4968	0,5244	0,5524	0,5279
CEL-USE	0,7562	1,0000	0,2104	0,1990	0,3546	0,3484	0,5057	0,5286	0,4993	0,4927
TV-TIME	0,3522	0,2104	1,0000	0,8756	-0,0831	-0,0779	0,0267	0,0455	0,2295	0,2142
TV-USE	0,3174	0,1990	0,8756	1,0000	-0,1657	-0,1283	-0,0158	0,0270	0,2106	0,2300
MW-TIME	0,3240	0,3546	-0,0831	-0,1657	1,0000	0,9380	0,3793	0,3520	0,2765	0,2647
MW-USE	0,3072	0,3484	-0,0779	-0,1283	0,9380	1,0000	0,3507	0,3479	0,2579	0,2731
PC-TIME	0,4968	0,5057	0,0267	-0,0158	0,3793	0,3507	1,0000	0,9341	0,5732	0,5524
PC-USE	0,5244	0,5286	0,0455	0,0270	0,3520	0,3479	0,9341	1,0000	0,5518	0,5728
ATM.-TIME	0,5524	0,4993	0,2295	0,2106	0,2765	0,2579	0,5732	0,5518	1,0000	0,9322
ATM.-USE	0,5279	0,4927	0,2142	0,2300	0,2647	0,2731	0,5524	0,5728	0,9322	1,0000

CEL: cellphone; MW: Microwave oven; PC: Personal Computer; ATM: Automatic *Teller Machine*

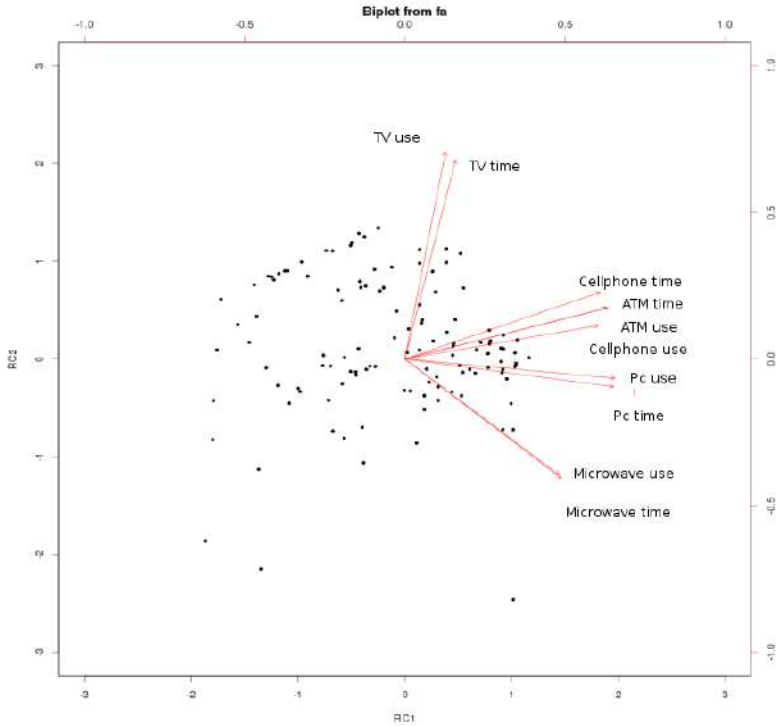
A componential analysis (PCA) was implemented so as to identify the variables more closely connected and/or assembled amongst each other. This analysis had as an entry the correspondent variable to the current use and the starting point for use of each of the instrument or devices researched. The result showed a close relation between some uses and functions. The score of the first component (PC1) was high for the relative variables to the cellphone, pc use and ATM. The scores for the second component (PC2) allowed to assemble the TV control remote use variables and in the third component the microwave use (Table 5).

Table 5: *First analysis of Principal Components (PCA1)*

	RC1	**RC2**	**RC3**	**h 2**	**u 2**
ATM Time	0.84	0.19	0.07	0.74	256
ATM Use	0.83	0.19	0.07	0.74	264
MW Time	0.21	- 0.09	0.95	0.95	50
MW Use	0.19	- 0.07	0.95	0.94	55
TV- time	0.09	0.94	-0.04	0.89	110
TV- use	0.08	0.94	-0.12	0.90	112
CEL. Time	0.65	0.41	0.30	0.67	326
CEL. Use	0.64	0.27	0.34	0.60	403
PC. Time	0.86	- 0.14	0.19	0.79	209
PC. Use	0.86	- 0.10	0.17	0.79	213

ATM: Automatic Teller Machine; MW: Microwave oven; TV: Television CEL cellphone; PC: Personal Computer.

A Biplot (Graphic 1) which verifies the assembling was obtained from the main components analysis. It is observed that the course of the cellphone arrows, the ATM and the use of the PC coincide but the TV and the microwave have opposite directions. In order to determine the relation between the score of change and the score of loss in reference to specific task a second analysis of main component was performed.



Graphic 1: *Principal Components Biplot*

On PC1 there is an inverse relation between the TV score of change (-0.76) with the cellphone score of change (0.89), the first one declines while the second one remains stable (without any changes).

PC2 shows a correlation between the score of loss of the microwave (0.66), the ATM (0.72) the cellphone (0.63) and the PC (0.55). It is worth mentioning that this last three functions are related to tasks that implied a higher cognitive activity. The TC3 shows a correlation between the score of change of the ATM (0.78) and the microwave (0.76) (Table 6).

Table 6: *Second analysis of Principal Components (PCA 2)*

	PC1	PC2	PC3	h2	u2	com
ATM Sc of ch	- 0.41	-0.01	0.78	0.78	0.222	1.5

ATM Sc of loss	0.04	0.72	0.00	0.52	0.477	1.0
MW Sc of ch	- 0.08	0.01	0.76	0.58	0.420	1.0
MW Sc of loss	0.05	0.66	-0.01	0.43	0.568	1.0
TV- Sc of ch	-0.76	0.00	- 0.41	0.75	0.247	1.5
TV- Sc of loss	-0.05	0.14	- 0.13	0.04	0.960	2.3
CEL. Sc of ch	0.89	0.04	-0.38	0.94	0.063	1.4
CEL. Sc of loss	0.03	0.63	0.00	0.40	0.599	1.0
PC-Sc of loss	- 0.01	0.55	- 0.04	0.31	0.693	1.0

Sc of ch: score of change; Sc of loss. score of loss

4. Discussion

Findings obtained for this study show the change and loss profile in complex activities performance in an aging population.

A lower percent of the sample suffered a functional loss. Relations obtained between age and instruction level manifested the educational significance in the assessed task. As we could observed older people with lower level of instruction suffered higher functional loss. A feasible hypothesis would be to interpret this fact in relation to a roll of education as one of the significant factors in the cognitive store. As regard changes in the executive function in normal aging, this population with low level instruction would have less chances to generate compensatory strategies, therefore they would be prone to a higher functional loss. In reference to performance changes participants between ages 69 and 80, the higher instruction, who performed more tasks where the ones who obtain higher changes compared to the group with less instruction level and who performed a lower number of tasks when beginning to use the different instruments.

These results would be the expected ones because the change obeys to slowing down in task performance to a higher number of trials when attempting to achieve the propose task and this manifestation would increase with the stored tasks. A possible interpretation for this finding is to reconsider the impact of the instruction level when generating strategies to optimize functional performance in the aging population.

Changes would occur due to the expected failings in the executive function and this would have an impact on speed and accuracy for the execution. This would generate a higher number of trials to attain the objective. They were mainly observed in the use of ATM and cellphone.

A correlation is verified between time of use (seniority in the use of the instrument assessed) and the use at assessment time. For example, correlation found between tasks allowed to infer that at a higher level of use of an instrument there is a higher probability to keep it through time.

It is once more verified that repetition and continuous activation stabilizes motor and cognitive engrams in the long term memory, a sort of cognitive groove.

In our first analysis (MCA) in component 1 activities are associated; cellphone time, cellphone use; PC time, PC use; ATM time, ATM use and to a lesser extent, microwave time, microwave use. This fact was analyzed in relation to tasks which require specific management of technologies that adults have incorporated late in life. We consider this finding is associated to those tasks which are negatively correlated with age (-0.5), this is because in the aging people a lower experience is observed in the use of new technologies.

The assembling of the tasks in PC1-cellphone, PC and ATM shows the existent correlation between high complexity tasks and the use of new technologies and the use of the ATM.

An interesting finding results from the second analysis of PCA where (PC2) shows a correlation in the loss of tasks associated to new technologies while PC3 assigns more importance to tasks associated to cover daily life needs such as food preparing with the microwave or the use of the ATM.

In PC 1 the scores of change for the TV remote control which has the highest everyday use are contrasted with the change in the cell phone which has a higher instrumental complexity.

We are in condition now to infer that loss or/and described changes would not answer to a randomized distribution of the assessed functions. The assembling found show a connection in the tasks determined by their function (new technologies, daily functionality).

In a recent study this scale was implemented in a population with MCI (Guajardo, Shoderlan & Labos, 2017) and the results were contrasted with a control group without cognitive impairment.

Results obtained with control population coincide with those of our study. Out of 269 evaluates patients 173 (64.3%) were diagnosed with MCI and 96(35.7%) were free cognitive impaired participants. MCI patients had a score measure of change higher to the control group 0.26(DS 0.4) and 0.060 (DS 0.21) respectively, thus showing a significant difference with P<0.001. The measure of the functional loss score was higher in DCL patients 1.94 (DS 2.24) compared with the control group subjects 0.31(DS 0.85), p <0.001.This results proved the significance of the implementation of CFS in the clinic.

To conclude, the present study shows changes and/or losses in Functional Complex Performance in a low proportion in a study population. These findings could be due to aging neurobiological and cognitive modifications. And also to the scarce implementation of compensatory strategies in this group. We coincide with other authors that processes associated to executive functions and their modification in aging would be the basis of change and/or functional losses. Consequently not every change and/or functional loss will necessarily represent a marker of pathological functional failure.

Obtained parameters in the studied population would allow for identification of grades and levels of change or functional loss not expected for the age and instruction and this would determine the presence of an incipient impairment in functionality as was corroborated in Guajardo´s study.

In the light of these results it is considered that CFS could be implemented in some neurological diseases that present functional impairment so as to get a quantified index of state and progression, complementing in that way the diagnostic evaluation.

Its clinical progression would allow implementing therapeutic strategies optimizing the executive functions in daily life complex activities

Several studies describe the functional cognitive association and its mutual correlation (Rubial-Álvarez, De Sola, Machado, 2013; Warren, 1989). Complex functional impairment can precede cognitive impairment in aging as well as in some neurological diseases. This functional cognitive interaction is stressed in the presence of any of the two most frequent causes of brain impairment in AD and in cerebrovascular disease (Bassett, 1991, Grigsby, 1998) .The CFS would have a sound clinical significance in incipient stages of functional impairment, mainly in subjects with high instruction level. We suggest the term Mild Functional Impairment to identify these clinical manifestations.

Obtained results show a significant percentage of adults keeping their functional level in reference to high complexity tasks, therefore it can be inferred that there is a good compensation of natural decline for executive functions, that as we saw, they are underlying processes for these activities. The psycho-social projection of these conclusions would lead us to infer that the elder population would be in condition to face the challenge of new learnings dependent of these functions, fostering a change in the cultural belief that old age always implies a substantial cognitive decline that results stigmatizing and painful.

These considerations allow for a double anchor of interest in the clinical area on the one hand and on the other hand in the field of the neuropsychology of the aging process, in reference to the functional state of the elder population and the effect of time on these learning experiences. The Functional Age of the individual might be the key element to challenge the Chronological Age.

4.1 CFS limitations for clinical use

- Difficult statistical interpretation of results in the standard population
- The scale is quantified but it is not specifically prepared to get a cut point. It can be implemented as part of the functional assessment with other diagnostic tools.
- In order to verify results a higher number of participants is required.

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