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Original Article

Comparative Study and Application of the EFA-4 Diagnostic Tool to Alzheimer's Disease and Mild Cognitive Impairment

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Abstract

Speech is a cortical function that includes virtual, mobile and sensory part for the understanding and the expression of spoken and written word. This study shows the Greek adaptation of the diagnostic tool «Examining for aphasia» or EFA -4. In dementia and especially in Alzheimer's disease–AD, the speech disorders are among the main diagnostic feature, along with the impairment of memory. How, however, will we recognize Dementia and separate it from the early stage of Mild Cognitive Impairment- MCI according to speech disorders?

The diagnostic tool EFA-4 is a regulatory, reliable and valid measure of the speech disorders. The test was administered to 50 normal elders, 50 patients with AD and 31 patients with MCI. The sample selection, although it had a uniform age, was regardless of origin, marital status and socioeconomic status. According to the results of the research, the EFA-4 is perceived to be particularly useful in the setting of language deficits of the patients with AD, who participated in the survey.

Specifically, the cut offs showed that the average of the EFA-4 for the normal range ranged from 74,5 – 74,8. Moreover the cut offs showed that the average of EFA-4 for patients with AD ranges from 36.8-46.1 and for patients with MCI ranges from 62.2 - 66.7.

Keywords: EFA-4, Speech Disorders, Dementia, AD, Mild Cognitive Impairment, MCI

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Definition

The scientific term aphasia refers to any loss -partial or entire- of linguistic ability in adults and children, as well as to any linguistic impairment after a normal brain function. Aphasia is defined as the acquired impairment in language comprehension, production and symbolic awareness (LaPointe,2005). In the case of aphasia, one is not able to speak, give words their correct meaning or understand language and is sometimes having difficulty to read and write. Every aphasic impairment is different and unique and is morphologically affected depending on the position, the severity and the time of injury. Aphasia is the result of brain injury (CVA, traumatic brain injury etc.). However, it has been proven that speech disorders and specifically aphasia are a common symptom of neurodegenerative diseases.

Speech disorders – Aphasia, Alzheimer's disease (AD) and Mild Cognitive Impairment (MCI)

The research in speech disorders, aphasia, dementia and AD is of great interest. It has been scientifically evidenced that aphasia is present in all types of dementia and it is also one of the diagnostic criteria (American Psychiatric Association,2000, McKhann,1984, Neary,1998). More specifically, the first Alzheimer's patient was aphasic (Alzheimer, 1907). Nevertheless, the fact that aphasia is a key characteristic of AD has only recently been noted. AD is the most common type of dementia, making up 2/3 of the total dementia incidents. In the past it was considered to be relatively rare, especially to people under the age of 65. During the first half of the 20th century, only 100 cases of aphasia were reported. Nowadays we know that aphasia is very common, especially in developed countries, while its frequency is constantly increasing exponentially as one gets older. Age is actually the most significant risk factor for the appearance of the disease. Between the ages of 65 and 88 the prevalence of the disease increases continuously reaching at the age of 85 the astonishing percentage of 35-40%. AD is not connected to typical aging and is characterized by non-typical decline in brain functions. Among the affected brain functions, speech holds a central role (Wetterling, Kanitz, Borgis, 1996).

Language depletion in AD is already evident during the first stages of the disease (Forbes, McKay,2005). All AD patients show aphasic speech disorders (Cummings,1985). AD speeds up language depletion, irrespective of the patient's age, compared to the depletion observed in typical aging and in Mild Cognitive Impairment- MCI (Kepner, 2001). In addition, the specific type of speech disorder in AD is different to that in Vascular Dementia (Kontiola, 1990, Jones, 2006) or Frontotemporal Dementia (Blair, 2007). The functional use of language, or pragmatics, contributes to the communication deficit in dementia (Deal, 1991). Patients are seen to face difficulties in topic retaining, they frequently change the topic of discussion and ask for directions; their speech is full of pauses and ambiguities and they have difficulty maintaining eye contact as well as taking turns during a conversation (Hutchinson & Jensen, 1980, Ripich, Vertes, Whitehouse, 1989). Pragmatic deficits might depend on the type of conversation (Kimbarow & Ripich, 1989). Speech in AD patients is described as incohesive (Ripich & Terell, 1998), with limited and disturbed content (Ripich, 1998, Bayles, 1982, Kirshner,Webb, Kelly, 1984) and a wide use of vague

references (Irigaray,1973, Ripich, 1998).

The lexical-semantic deficits in AD are characterized by limited vocabulary (De Ajuriaguerra, Tissot, 1975) difficulty in naming (Bayles, Tomoeda, 1991) which are probably caused by a disruption in mental processing, perhaps in the preverbal stage (Bayles, Boone, 1982). Lexical difficulty is one of the very first deficits observed in people with dementia (Schuell, Jekins, Jimenez-Pabon, 1965). The majority of researchers seem to be in favor of the view that difficulties in word retrieval are due to a mental and not a perceptual deficit (Appell, 1982, Bayles,Boone, 1982,1983, Tomoeda, Caffrey, 1983, Kirshner, 1984, Skeleton, Robinson,Jones, 1984).

Nonetheless, syntax remains intact in AD, except for the developed stages (Appell, 1982, Bayles, Boone1982,1983, Obler,1981, Schwartz,1979, Whitaker, 1976). But there have been reported syntactic mistakes, such as loss of phrases and sentences, as well as pausing between phrases and grammatical disagreement during the early stages (Goodglass,Blumstein, Gleason, 1979). Syntactic comprehension is relatively weaker that production (Linebarger, Schwartz, Saffran, 1983, Kempler, Curtiss, Jackson, 1987). One explanation might be that syntax is a relatively automated mental function which is maintained among a more general mental deficiency (Kempler, 1987).

As for phonology, the phonological deficits in people with AD are rarely evident and only in developed stages of the disease. Even though research has reported certain phonological mistakes, they appear to be indicative of a bigger semantic or syntactic problem and not part of a single problem relating to 'lexical sound' or morphophonemes (separate linguistic units which indicate a change in meaning).

In brief, AD can be divided into three stages. In the first stage of AD, regarding pragmatics, there is difficulty in the usage of nominal references, as well as in coherence, directing, narration of stories, understanding humor, sarcasm and also abstract ideas; there is also difficulty in initiating speech as well as maintaining the same topic of discussion. There has also been reported an inability in finding words as well as frequent use of circumlocutions and gestures. There are usually no mistakes in syntax and phonology at this stage. In the second stage of moderate AD, as far as syntax is concerned, there is poor use of nominal reference, bad cohesion and bad topic maintenance. Expression of fewer ideas and frequent repetitions are observed. Speech is more and more based on stereotypical expressions. In semantics, there is poor flow of words with limited vocabulary and increased use of circumlocutions and meaningless replacements. It also usual to encounter empty speech. In syntax, there are fewer occasional grammatical mistakes and difficulty in understanding complex structures. In phonology there are hardly any mistakes. In the third (or late) stage of AD we notice lack of coherence, difficulty in maintaining eye contact, expression of some irrelevant to the topic ideas, persistence and meaningless speech and even alalia. In semantics, there are paraphasias, echolalia, very poor comprehension, severely damaged ability to name, frequent ideologues and incomprehensible speech. In syntax, grammar is generally maintained. There is use of fragmented and incomplete sentences, as well as poor comprehension of grammatical structures. Phonological mistakes are also common in the third stage.

Despite the universality of aphasia, its qualitative composition and severity varies depending on the pathological process and location (Wetterling, 1996). It is the duty of health professionals to put forward an accurate diagnosis and then design a complete treatment schedule. What we ought to have in mind is that the more accurate the diagnosis is, the more effective the treatment will be.

Mild Cognitive Impairment (MCI) is considered to be a precursor of AD (Ronald, Petersen, 2014, Knopman, 2014). MCI patients show memory impairments or disruptive thinking and difficulty in making decisions, but their daily activities remain intact (i.e. they cook, drive, have sense of orientation, take care of themselves, take their medicine by themselves). It is important for the diagnosis of the disease that those impairments not be compatible with the patient's age and the typical aging process. For instance, we should not be referring to MCI when a 90-year-old patient shows mild memory impairment symptoms, but such symptoms play a crucial role in the diagnosis if they are found in a 60-year-old person (Tsolaki, 1997, Tsolaki, Kazis, 2005).

Importance of the disease

Epidemiological studies have shown that 10 to 20% of the people over the age of 65 suffer from MCI. Half of them deteriorate in the next 5 years and are diagnosed with AD.

Development of brain functions.

MCI is divided into two subtypes:

MCI Amnestic Type: One may start forgetting important information which he or she used to remember easily, such as meetings, conversations or recent events.

MCI Non-Amnestic Type: Certain brain functions are affected, but memory remains intact. The abilities that can be affected by Non-Amnestic MCI are those of decision making, sound recognition and sense of time. In other cases, patients are unable to follow the steps required to complete a complicated task or their visual perception might deteriorate.

Material and Methodology

What the diagnostic tool EFA-A is?

EFA-4 is a regulatory, reliable and valid measurement of aphasia. It is appropriate for adults whose language functions have weakened after they had initially been normally acquired. EFA-4 offers to the clinician a method to assess possible aphasic language impairments and other acquired disorders that are often connected to language functions. It also allows the examiner to be informed about a patient's participation in life and activities that might have been altered due to aphasia.

EFA-4 subtests

EFA-4 involves 10 subtests which were created in order to assess the basic brain functions. Those subtests include visual recognition, sound recognition, tactile recognition, sound perception of oral speech and silent recognition with comprehension. In addition, the non-verbal and verbal activities are tested as well as meaningful speech production and meaningful writing. Finally communicative and descriptive speech is also tested.

EFA-4 sections

EFA-4 consists of the examiner's handbook, a picture book, the results sheet – a diagnostic form, the results sheet – a form of brief testing, the answer sheet-diagnostic form, the answer sheet-a form of brief testing, the brief diagnostic form, the personal background and the items box. In the study we conducted we needed and

made use of the results sheet - diagnostic form , the results sheet and the items box.

Uses of EFS-4

EFA-4 is a well structured tool with excellent psychometric properties. It has 3 main uses: a) to detect the presence of aphasia b) to define the severity of aphasic symptoms and their effect on participation in life and activities, c) to set goals for the treatment of communication, d) to record the progress made during treatment and e) to help health professionals inform and consult people suffering from aphasia, their families and their support system.

Grading in the procedure

The activities are graded 2, 1 or 0. The main parameters of the test-taker's answers that have to be taken into account during grading are precision, consistency and effectiveness. Grade 2 should be given to an activity for an answer which in correct, prompt and adequately produced. Also, grade 2 is achieved when the test-taker indicates or writes correctly as required.

Grade 1 should be given for an answer which is correct but, according to the examiner, has been delayed or inadequately produced (usually due to non-typical, precarious or poorly coordinated verbal or written movements). Grade 1 should also be given when an answer itself is correct but the formation and form of the answer is not correct (i.e. a written answer to an oral question or a mapping answer to a question that requires indication).

Grade 0 is to be given if the test-taker does not respond at all to the activity or gives incorrect answers. The examiner must make a note of the cases where no answer is given by writing N.A. (no answer) next to the activity in addition to grade 0.

The grading of answers in EFA-4 activities requires thorough observation of behaviors as well as critical evaluation.

Methodology of the study

Study design

The study was divided into four parts. In the first one we translated it into Greek.

Next, we conducted a pilot study in order to check the adaptations in the Greek language. The third part consisted of the assignment of the tool, the codification elements and the introduction of data. The fourth part had to do with the analysis of the data and the interpretation of the results.

Translation and adaptation of the tool

The translation of EFA-4 from English to Greek was done accordingly: the initial editions of the tool were translated separately by three native speakers of Greek who were proficient in oral and written English. The results of the three editions in Greek were translated once again into English by three individual native speakers of English who were proficient in oral and written Greek. From the three translations, the picture-stimuli which were translated precisely from English to Greek and vice versa were included in the final editions of the tool. Additionally, the final Greek editions were given to three bilingual (English-Greek) judges, along with the English editions to attest the final result. Finally, two speech therapists and one linguist –who edited the changes in a linguistic and lexical level- were chosen to check if the adaptations were satisfactory and they affirmed the final Greek edition.

The pilot study

The pilot study was conducted between July 2010 and January 2011 in order to

define the difficulty of the objects and check their validity and other characteristics.

Sample

In the present study the tool was administered to 50 adults individually. The selection of the sample, even though it was homogeneous in terms of age, was done irrespective of origin, marital status and socio-economic background. It should be noted that in order to succeed in the administration of the scale and measurements, all participants were assured that their personal information will remain private and they also signed a consent form.

Data collection procedure

The administration of the tool took place for all 50 participants at the outpatient Memory and Dementia sector of the 3rd Neurological department of G.Papanikolaou Hospital with the patient and their doctor present. After the introduction, the test-takers were informed about the purpose of the study and they were asked to sign the consent form. Then, they were seated at a table opposite and slightly to the right of the examiner. The lighting conditions were appropriate and the materials were placed in such a way so that the patients could see and use them without any difficulty. The administration of the tool followed the same procedure for all participants according to the directions given in the examiner's handbook.

During the assessment procedure the examiner did not change their facial expressions nor did they express any verbal disapproval. But in order for the participants to achieve the highest performance and best response there was considerable encouragement on the part of the examiners who were supportive but at the same time objective. They told the participants when they did well and reassured them when they failed. A simple and honest way to do this according to Schuell (1964) is to comment on reality, when the test-taker is facing a difficulty with a task given to them. This will help the patient relax, retrieve their thoughts and strength and have a clear mind to move forward. This is what every examiner should learn. This is not an easy task and it is surely not done in order to collect meaningless numbers. The main goal is the cooperation between patient and examiner. The examiner must approach the patient, touch them, understand them and talk to them. There should be a channel of communication. Always with a smile and discussion.

The duration of the procedure varies from test-taker to test-taker but the average duration is 45 to 60 minutes.

Results of the study

In order to examine the research purposes it is necessary to group the variable of the study. Table 1 shows the reliability results through the variable Cronbach Alpha. We notice that all values of the contributing factor are over 0.722, which indicates reliability since generally all values above 0.7 are satisfactory. Hence we are allowed to group the variables of the study. Table 2 shows the results of the ANOVA test about whether there are differences between typical people and people with dementia and people with a disorder. The choice of this test was made because all subpopulations are over 30 in number; as a result, due to the CLT (Central Limit Theorem), average values follow the common distribution and therefore the use of parametric statistical tests is suggested. The initial hypothesis is that average values are equal and the alternative

Table 1: Coefficient Cronbach Alpha

Reliability

Topic	Number of questions	Cronbach's Alpha
Recognition	3	0,722
Language Comprehension	6	0,864
Non verbal activities	3	0,838
Verbal activities	3	0,867
Language production	6	0,903
Expression-Production	13	0,94
Arithmetic Procedures	2	0,82
Meaningful Writing	4	0,876

Table 2: Results in ANOVA

ANOVA

		df	F	Sig.
Recognition	Between Groups	2	52,882	,000
	Within Groups	128		
	Total	130		
Language Comprehension	Between Groups	2	244,562	,000
	Within Groups	128		
	Total	130		
Expression-Production	Between Groups	2	82,634	,000
	Within Groups	127		
	Total	129		
Arithmetic Procedures	Between Groups	2	130,386	,000
	Within Groups	128		
	Total	130		
Meaningful Writing	Between Groups	2	106,020	,000
	Within Groups	128		
	Total	130		
Speech	Between Groups	2	27,607	,000
	Within Groups	128		
	Total	130		
MMSE/HINDI	Between Groups	2	130,005	,000
	Within Groups	121		
	Total	123		

Table 3: Descriptive facts

		N	Mean	Std. Deviation
Recognition	Control	50	109,70	,707
	AD	50	76,52	27,627
	MCI	31	105,77	3,998
	Total	131	96,11	23,075
Language Comprehension	Control	50	98,68	2,369
	AD	50	39,92	18,866
	MCI	31	74,90	12,998
	Total	131	70,63	29,068
Expression-Production	Control	50	169,28	1,604
	AD	49	109,35	37,481
	MCI	31	152,42	11,141
	Total	130	142,67	35,660
Arithmetic	Control	50	19,84	,468
	AD	50	6,32	5,389
	MCI	31	15,10	5,344
	Total	131	13,56	7,315
Meaningful Writing	Control	50	49,60	1,010
	AD	50	17,30	16,489
	MCI	31	37,77	9,380
	Total	131	34,47	18,089
Speech	Control	50	1,00	,000
	AD	50	1,66	,798
	MCI	31	1,00	,000
	Total	131	1,25	,586
MMSE/HINDI	Control	50	29,62	,697
	AD	43	18,51	5,234
	MCI	31	26,03	2,442
	Total	124	24,87	5,886

Graph : Average values of the people. In the horizontal line value 1 stands for Recognition, value 2 for Language Comprehension, value 3 for Expression-Production, value 4 for Arithmetic Procedures, value 5 for Meaningful Writing, value 6 for Speech and value 7 for MMSE/HINDI

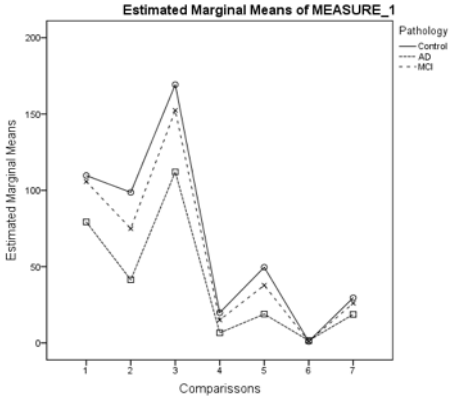

Table 4: Results of the Tukey test for multiple comparisons

Tukey HSD				
Dependent Variable	(I) Pathology	(J) Pathology	Mean Difference (I-J)	Sig.
Recognition	Control	AD	33,180*	,000
		MCI	3,926	,579
	AD	Control	-33,180*	,000
		MCI	-29,254*	,000
	MCI	Control	-3,926	,579
		AD	29,254*	,000
Language Comprehension	Control	AD	58,760*	,000
		MCI	23,777*	,000
	AD	Control	-58,760*	,000
		MCI	-34,983*	,000
	MCI	Control	-23,777*	,000
		AD	34,983*	,000
Expression-Production	Control	AD	59,933*	,000
		MCI	16,861*	,006
	AD	Control	-59,933*	,000
		MCI	-43,072*	,000
	MCI	Control	-16,861*	,006
		AD	43,072*	,000
Arithmetic Procedures	Control	AD	13,520*	,000
		MCI	4,743*	,000
	AD	Control	-13,520*	,000
		MCI	-8,777*	,000
	MCI	Control	-4,743*	,000
		AD	8,777*	,000
Meaningful Writing	Control	AD	32,300*	,000
		MCI	11,826*	,000
	AD	Control	-32,300*	,000
		MCI	-20,474*	,000
	MCI	Control	-11,826*	,000
		AD	20,474*	,000
Speech	Control	AD	-,660*	,000
		MCI	,000	1,000
	AD	Control	,660*	,000
		MCI	,660*	,000
	MCI	Control	,000	1,000
		AD	-,660*	,000
MMSE/HINDI	Control	AD	11,108*	,000
		MCI	3,588*	,000
	AD	Control	-11,108*	,000
		MCI	-7,521*	,000
	MCI	Control	-3,588*	,000
		AD	7,521*	,000

Table 5: Results of the Man Whitney tool for gender

	Recognition	Language Comprehension	Expression Production	Arithmetic procedures	Meaningful Writing	Speech	MMSE HINDI
Control	,674	,132	,923	1,000	,794	1,000	,319
AD	,830	,573	,685	,190	,033	,513	,706
MCI	,003	,598	,569	,457	,067	1,000	,771

Table 6: Results for the Kruskal Wallis tool for age

	Recognition	Language Comprehension	Expression Production	Arithmetic procedures	Meaningful Writing	Speech	MMSE HINDI
Control	,301	,370	,079	,284	,289	1,000	,445
AD	,855	,997	,923	,434	,721	,422	,293
MCI	,279	,377	,406	,484	,567	1,000	,769

Table 7: Results for the Kruskal Wallis tool for educational level

Recognition	Language Comprehension	Expression Production	Arithmetic Procedures	Meaningful Writing	Speech	MMSE HINDI
Control	,346	,497	,513	,314	,940	1,000	,811
AD	,120	,151	,127	,106	,046	,261	,708
MCI	,688	,213	,310	,254	,092	1,000	,694

Table 8 : Average values for the variable Meaningful Writing for gender for people with AD

AD	N	Mean	Std. Deviation
Male	17	24,5882	19,78339
Female	33	13,5455	13,33719
Total	50	17,3000	16,48902

Table 9 : Average values for the variable Recognition for gender for people with MCI

MCI	N	Mean	Std. Deviation
Male	12	103,5000	5.68091
Female	19	107.2105	1.13426
Total	31	105.7742	3.99758

Table 10: Average values of the variable Meaningful Writing for educational level for people with AD

AD	N	Mean	Std. Deviation
5-	28	11,9643	11,52287
6-10	10	17,8000	17,75638
11-15	5	17,2000	19,77878
16+	7	38,0000	16,00000
Total	50	17,3000	16,48902

Table 11: Pearson correlations for the variable MMSE/HINDI for typical people

Typical		MMSE HINDI
Recognition	Pearson Correlation	,054
	Sig. (2-tailed)	,710
	N	50
Language Comprehension	Pearson Correlation	-,187
	Sig. (2-tailed)	,195
	N	50
Expression Production	Pearson Correlation	,024
	Sig. (2-tailed)	,868
	N	50
Arithmetic Procedures	Pearson Correlation	-,065
	Sig. (2-tailed)	,653
	N	50
Meaningful Writing	Pearson Correlation	,041
	Sig. (2-tailed)	,780
	N	50
Speech	Pearson Correlation	.[a]
	Sig. (2-tailed)	.
	N	50

AD		MMSE HINDI
Recognition	Pearson Correlation	,711**
	Sig. (2-tailed)	,000
	N	43
Language Comprehension	Pearson Correlation	,839**
	Sig. (2-tailed)	,000
	N	43
Expression Production	Pearson Correlation	,812**
	Sig. (2-tailed)	,000
	N	42
Arithmetic Prodecures	Pearson Correlation	,748**
	Sig. (2-tailed)	,000
	N	43
Meaningful Writing	Pearson Correlation	,592**
	Sig. (2-tailed)	,000
	N	43
Speech	Pearson Correlation	-,741**
	Sig. (2-tailed)	,000
	N	43

Table 12: Pearson correlation for the variable MMSE/HINDI for people with dementia

MCI		MMSE HINDI
Recognition	Pearson Correlation	,144
	Sig. (2-tailed)	,439
	N	31
Language Comprehension	Pearson Correlation	,400*
	Sig. (2-tailed)	,026
	N	31
Expression Production	Pearson Correlation	,427*
	Sig. (2-tailed)	,017
	N	31
Arithmetic Procedures	Pearson Correlation	,163
	Sig. (2-tailed)	,380
	N	31
Meaningful Writing	Pearson Correlation	,201
	Sig. (2-tailed)	,278
	N	31
Speech	Pearson Correlation	.b
	Sig. (2-tailed)	.
	N	31

Table 13: Results of the multiple linear regression for typical people

Model	Control	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	34,340	19,955		1,721	,092
	Recognition	,041	,149	,042	,276	,784
	Language Comprehension	-,060	,045	-,205	-1,351	,184
	Expression Production	-,002	,067	-,005	-,033	,974
	Arithmetic Procedures	-,155	,225	-,104	-,689	,494
	Meaningful Writing	,003	,107	,005	,031	,976
	R: ,217[a]					
	Sig: ,821[b]					

Table 14: Results of the multiple linear regression for people with dementia

Model	NA	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	14,338	3,745		3,829	,001
	Recognition	-,005	,029	-,026	-,175	,862
	Language Comprehension	,122	,066	,440	1,835	,075
	Expression Production	,022	,035	,155	,632	,532
	Arithmetic Procedures	,225	,185	,234	1,216	,232
	Meaningful Writing	-,048	,046	-,151	-1,048	,302
	Speech	-2,155	1,040	-,282	-2,073	,046
	R: ,873[a]					
	Sig: ,000[b]					

Table 15: Results of the multiple linear regression for people with MCI

		Unstandardized Coefficients		Standardized Coefficients		
	HNΔ	B	Std. Error	Beta	t	Sig.
1	(Constant)	28,278	17,577		1,609	,120
	Recognition	-,207	,203	-,338	-1,018	,318
	Language Comprehension	,035	,057	,184	,603	,552
	Expression Production	,111	,074	,507	1,495	,148
	Arithmetic Procedures	-,046	,117	-,101	-,397	,695
	Meaningful Writing	,020	,098	,078	,207	,838
	R: ,490[a]					
	Sig: ,201[b]					

hypothesis is that at least one average value is different. The initial hypothesis is proven when Assymp.Sig ≥0.05 and it is rejected when Assymp.Sig<0.05. We notice in Table 2 that there is a statistically significant difference in all cases. Table 3 and the Graph indicate the differences in average values. We notice that the typical people present higher values that people with MCI, and MCI patients present higher values that people with dementia. Table 4 shows that the differences are statistically significant through the Turkey test since in almost all cases Assymp.Sig<0.05. Only in the variable Recognition and Speech are the differences between typical people and people with disorders statistically insignificant.

In Tables 5-7 we notice the correlations between typical people, people with MCI and people with AD and the demographics, gender, age and educational level respectively. The statistic tool used is the non parametric test Kruskal Wallis due to limited samples for the cases where 3 categories of samples are created; and the non parametric tool Man Whitney where 2 categories of samples are created (e.g. gender). The initial hypothesis is that the samples created at the crossings come from the same population, whereas the alternative hypothesis states that they come from different populations. The initial hypothesis is proven when Assymp.Sig.≥0.05 and it is rejected when Assymp.Sig<0.05. The rejection of the zero hypothesis indicated dependence of the variables. We notice that with regard to gender two statistically significant correlations are found; whereas with regard to educational level there is one statistically significant correlation. In Tables 8-9 is it obvious that males with AD show higher values compared to females in the value Meaningful Writing and males with MCI lower values in Recognition. Finally, in Table 10 we notice that in the category of people with AD the value of Meaningful Writing increases proportionally to the educational level. In Tables 10-12 we are presented with the linear correlations of the variables of the study with the variable

MMSE/HINDI for typical people, people with AD and people with MCI respectively. We notice that in typical people there are no statistically significant correlations, in people with AD there statistically significant correlations in all cases and in people with MCI there are statistically significant correlations in two cases.

In Tables 13-15 below, we are presented with the results of the multiple linear models for typical people, people with AD and people with MCI. Every time the dependent variable is MMSE/HINDI and the independent variables are Recognition, Language Comprehension, Expression Production, Arithmetic Procedures, Meaningful Writing and Speech. The coefficients R^2 of the models are 0.217, 0.873 and 0.49. This indicated that the model is well adapted only for people with dementia. In this case only the variable Speech does not affect the variable MMSE/HINDI.

Triggering Thresholds

In our effort to find specific thresholds that indicate if a person belongs to the category of AD, MCI or Control we group the variables Recognition, Language Comprehension, Expression-Production, Arithmetic Procedures, Meaningful Writing and Speech thus creating the variables «MESO_EFA_AD»,«MESO_EFA_ MCI» and «MESO_EFA_Control» by calculating the average value of the variables mentioned for every category. The 95% confidence intervals are evident in the Table below.

In order to investigate the research objectives it is necessary to group the research variables. Table 1 shows the results of reliability through the Cronbach Alpha coefficient. We note that all coefficient values are greater than 0.722, which suggests reliability as more satisfactory values are greater than 0.7.

Therefore, it is permissible to group the variables of the survey. Table 2 shows the results of the ANOVA test on whether there are differences between normal individuals, dementia and people with disorder. The choice of this test was made as all subpopulations had a number of more than 30, resulting in the KOOT. (Central Limit Theorem), the average values follow the normal distribution and therefore the use of parametric statistical tests is appropriate. The initial assumption is that the average values are equal and the alternative that at least one mean is different. The original hypothesis is accepted when Assymp.Sig $\geq$0.05 and discarded when Assymp.Sig <0.05.

We see in Table 2 that there is a statistically significant difference in all cases. Table 3 and Figure show differences in mean values. We notice that normal individuals show higher rates than those with ADHD and those with higher than normal CID rates than those with dementia. Table 4 shows that differences are statistically significant through the Tukey test as in almost all Assymp.Sig cases <0.05. Only in the cases of the Recognition and Reason variables the differences between normal individuals and individuals with disorder are not statistically significant (Koliva, Machera, Bora, Seda, 1998).

Discussion

The aim of the study was the pilot application of EFA-4 in Greek to people with MCI and AD. Also, the aim was to examine the selected stimuli and whether they can lead to a possible diagnosis of the presence or not of language disorders in AD, as well as to test the validity and reliability of this specific tool.

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
MESO_EFA_NA	17.948	49	.000	41.51067	36.8628	46.1585
MESO_EFA_Control	1020.369	49	.000	74.68333	74.5362	74.8304
MESO_EFA_HNΔ	59.017	30	.000	64.49462	62.2628	66.7264

There is no other similar study in global bibliography so as to compare the results. For this reason we studied every axis separately in other studies. In Greece there are several weighted-adapted studies which indicate the dynamic distinction between the typical people and people with mental-speech pathology, in the field of aphasia, similar to the condition of EFA-4 in this particular study (Tafiadis,2008,2009,2010). However, there is no specific tool yet that bounds AD and MCI. Our whole effort is concentrated on this delicate issue.

There is a statistically significant difference between the typical people and AD patients in all cases irrespective of variables, something that is proven by the studies conducted by Mueller KD et al, where the distinction between typical people and dementia patients is also evident. Between typical people and MCI patients there is a statistically significant difference in all cases irrespective of variable, except for the variables Recognition and Speech, which is also evident in the Minnesota Test, used for differential diagnosis in adults with aphasia (Tafiadis, 2006) and where we can see that there is a statistically significant difference between patients and typical people. Finally, between people with AD and people with MCI there is a statistically significant difference in all cases irrespective of variables.

There is statistically significant difference for the dependent variable MMSE/HINDI between typical people, people with AD and people with MCI. This result is also indicated in the studies of Tom Tombaugh and Arevalo-Rodriguez I where the variable MMSE separates typical people from patients with AD and patients with MCI(Arevalo, Rodriguez, 2015, Tombaugh, 1992).

We observe a statistically significant difference of the independent variables with regard to gender in the variables Recognition for the people with disorder and in the variable Meaningful Writing for the people with AD.

There is a statistically significant difference of the independent variables with regard to educational level in the variable Meaningful Writing for the people with AD. This difference is also proven by the studies of Murdoch and Kemper 1987 and 1993, where the educational level plays the main role in writing.

There is a statistically significant linear correlation of the variable MMSE/HINDI with all independent variables in the case of people with AD and only with the variables Language Comprehension and Expression-Production in people with MCI. This is in agreement with the research data in Tafiadis et al, from aphasic patients is Greece, where disorders in expression, production and reading are indicated. The multiple linear model is well adapted and predicts the dependent variable MMSE/HINDI from the independent ones only in the case of

people with AD. In the model, however, the variable Speech is not considered statistically significant.

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