Creation and design of a test for the Evaluation of Upper Limb Apraxia (EULA) based on a cognitive model: a pilot study

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Introduction. Apraxia is regarded as neurological disorder characterized by a loss of ability to execute and carry out skilled movements and gestures despite intact motor and sensory systems, coordination, and comprehension. As reflected in the specialized literature, there are currently few tests that provide a global evaluation of this syndrome. This research created and designed a test for the Evaluation of Upper Limb Apraxia (EULA), based on theoretical models of apraxia.

Subjects and methods. A sample of 57 patients was selected with subjective cognitive manifestations (complaints of cognitive impairment) and 39 subjects without cognitive impairment. Both groups were given the EULA test as well as other tests. The structure of the EULA was verified with principal components factor analysis, and the reliability and validity of this instrument were also calculated.

Results. The factor analysis classified all of the items in the test in nine factors with an explained total variance of 69.91%. The high reliability of the test was reflected in a Cronbach's alpha of 0.929 and a Guttman split-half coefficient of 0.870. The construct validity was also satisfactory as shown in the significant correlation of six of the nine factors in the test with two other well-known apraxia subtests.

Conclusions. The healthy subjects had a higher test score than the subjects with complaints of cognitive impairment, which confirmed the reliability and construct validity of the EULA.

Key words. Apraxias. EULA test. Mild cognitive impairment. Symptom assessment. Test. Upper limb apraxia.

Introduction

The term, apraxia, was first used by Steinthal in 1871 to refer to a collection of disorders in which the common feature is the loss of ability to carry out skilled movements and gestures correctly on command and in the absence of paralysis. This conception has evolved and is still evolving as perceptions of this dysfunction have changed over the years [1]. Apraxia is conventionally defined as the inability to carry out learned skilled motor acts despite intact motor and sensory systems, coordination, comprehension, and cooperation [2]. However, the disorder is currently conceived as any motor ability impairment acquired in the absence of motor impairments such as weakness, akinesia, loss of input, abnormal tone or posture, or movement disorder [1], which occur as the result of a neurological dysfunction [3]. There are different conceptual and clinical classifications of this syndrome; an example of a representative type could be ideomotor apraxia [4,5].

Limb apraxia comprises a wide spectrum of higher motor disorders caused by acquired brain disease, affecting the performance of skilled learned movements carried out by the upper limbs [6]. Movements can be assessed by means of different modular praxic categories, such as the imitation or pantomiming of symbolic (meaningful) and non-symbolic (meaningless) gestures. Symbolic gestures are further classified as transitive (related to object/tool use) or intransitive verbal commands, which are essentially communicative by nature. Apraxia can also be assessed with tests in which subjects must name the action after to see using an object/tool, describe the function of an object presented visually and recognize whether a movement performed is correct. Other tests are the use of a real object and the performance of a serial action in which no object is involved [6-9].

Apraxia often occurs in a mild form when patients use objects and tools in familiar surroundings. This means that even the patient's own family members might not be aware of the disorder. For this reason, the clinical interview does not always provide useful information for the diagnosis of apraxia. It is thus necessary to give the patient a battery of tests that directly assess the disorder [7,8].

However, there are few tests for upper limb apraxia described in the specialized literature on the topic, and hardly any that have been validated in Spain with Spanish-speaking subjects. Guidelines regarding those aspects that should be evaluated in patients with this disorder can be found in Heilman et al. [9]. Their neurocognitive model of limb apraxia and apraxia is one of the most influential and provides a theoretical framework for the diagnosis and assessment of this syndrome.

Furthermore, there are hardly any apraxia tests that cover all the domains and characteristics of the performance of motor actions as indicated by different neurocognitive models at the theoretical level [10,11], and the majority of these tests use populations with localized brain damage produced by ictus or cerebrovascular accident (CVA) [10-12]. Even though apraxia is a disorder that frequently affects people with left-hemisphere acquired brain disease, there are also studies that demonstrate its occurrence in patients with neurodegenerative brain disease, such as mild cognitive impairment (MCI) and primary dementia [13-15].

Complaints of cognitive impairment, such as subjective manifestations of memory loss, usually come to light in the doctor's office and are generally communicated to the physician by family members or caregivers [16]. Such complaints often reflect different pathologies or neurological syndromes such as MCI and/or dementia.

The study described in this paper created and designed the EULA, a test for the assessment of upper limb apraxia, which integrates all the various aspects that compose this disorder at the theoretical level. The guidelines provided in Heilman et al and other authors [6-9,11] were used to elaborate the EULA test, which was designed in a study of patients with subjective complaints of cognitive impairment.

Subjects and methods

Sample

The group of subjects with complaints of cognitive impairment (CCI) was selected in the Dementia Care Unit of the Neurology Service from the Virgen de las Nieves Hospital in Granada (Spain). There were 57 subjects in this group, 25 males and 32 females, with a mean age of 75.05 and standard deviation of 8.55. These patients had visited the Dementia Care Unit for the first time because they, a family member, or a caregiver had observed signs of cognitive impairment.

The subjects in the control group, who had no cognitive impairment, were recruited by means of snowball sampling, a non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances. There were 39 subjects in this group, 11 males and 28 females, with a mean age of 61.21 and standard deviation of 10.45.

All participants were informed of the nature of this research study and its objectives, and agreed to participate by giving their written informed consent. The rights of all participants in this study were safeguarded by the ethical principles in the Declaration of Helsinki.

Diagnostic procedures

Standard Cognitive Assessment (SCA)

The instrument used for standard cognitive assessment is based on a battery of tests developed at the Universitary Hospital Virgen de las Nieves, Granada, known as the *Batería Abreviada Granada de Evaluación Neuropsicológica* (BAGEN), which has been used to assess dementia in patients with a low educational level. It is a valid instrument for the measurement of cognitive dysfunctions since it provides a profile of the cognitive level of the patient. The maximum scores in each subtest are, 30 in total learning curve, 15 in total digits, 15 in naming, 10 in comprehension, 10 in similarities, 10 in calculation, 12 in motor apraxia, 10 in visual construction, 10 in memory, 20 in recognition, and 10 in discrimination [17]. To validate the EULA test, the subtests for motor apraxia and visual construction were used.

Phototest

The Phototest is a simple instrument of very short duration (< 3 minutes) that can be used to detect cognitive impairment and dementia. The phototest has a high internal consistency (Cronbach alpha: 0.94), high test-retest reliability (intraclass correlation coefficient, ICC: 0.89) and interobserver (ICC: 0.98). This made it especially suitable for the cognitive screening of the control group, with cut-off point set at a score of 28-29 [18-20].

Test for the Evaluation of Upper Limb Apraxia (EULA)

The objective of the EULA is to assess specific upper limb apraxia in patients who complain of cognitive impairment. It is composed of 32 items, in which the patient is asked to perform different actions, specifically referred to in the literature as praxic func-

Table I. Nine factors of the EULA test and the items of each factor.

Factor 1. Gesture production by imitation and verbal command	Item 1	Hand position imitation: left hand opened and right hand closed
	Item 2	Hand position imitation: opposition of the index and little fingers
	Item 8	Gesture imitation of opening a bottle of water.
	Item 11	Gesture imitation of open a bottle of wine
	Item 12	Make the gesture of asking about: 'How much does something cost?'
	Item 13	Make the gesture of being crazy
	Item 20	Make the gesture of scolding someone
	Item 41	Make the gesture of filling a glass of water
Factor 2. Incorrect gesture recognition	Item 23	Use fingers like a toothbrush
	Item 24	Use thumb and forefinger like scissors
	Item 25	Use a finger as a screwdriver
	Item 26	Use a fist as a hammer
	Item 27	Increase the movement of moving the coffee, and using a finger as a teaspoon
Factor 3. Performance of serial or sequential action	Item 3	Put your hands perpendicularly to each other after seeing the evaluator
	Item 15	Act as if would spread butter on toast
	Item 38	Act as if would introduce a letter in an envelope and would put a stamp
	Item 39	Act as if would light a candle, with a match inside a box
	Item 40	Act as if would put toothpaste on a toothbrush and brush your teeth
Factor 4. Recognition of object/tool function	Item 19	Recognize the simulation of sawing with a saw after see the performing of the evaluator
	Item 21	Recognize the function of a match
	Item 22	Recognize the function of a shower sponge
	Item 36	Putting a clinical robe
	Item 37	Buttoning a button
Factor 5. Gestures or movements representing the use of the object/tool	Item 16	Make as if would cut a paper with scissors
	Item 17	Make as if would drive a clove with a hammer
	Item 18	Make as if would move a coffee with a teaspoon
Factor 6. Gesture imitation of complex movements	Item 4	Gesture imitation of hands butterfly shaped
	Item 6	Gesture imitation of 'driving a clove with a hammer'
Factor 7. Good-bye gesture	Item 9	Perform the good-bye gesture
Factor 8. Complex sequence of two-finger postures	Item 5	Gesture imitation of two rings chains, formed by the thumb and forefinger
Factor 9. Performance of routine gestures	Item 7	Gesture imitation of drinking a glass of water
	Item 10	Say with your hand 'Come here!' or make gesture of calling someone

tions. The performance of each action was assessed on a three-point Likert scale from 0 to 2. On this scale, an evaluation of 0 meant that the trajectory of the gesture was not performed or was unrecognizable by the evaluator; 1 meant that the action was recognizable, though not entirely correct because of some flaw in semantic content, the spatial or temporal orientation of the trajectory, or the use of a part of body like an object/tool; 2 meant that the action was correctly performed with no observable errors.

The EULA has nine factors. The first factor is gesture production by imitation or verbal command, whereby a patient has to imitate four gestures and perform four gestures after listening to a named gesture. The second factor is incorrect gesture recognition, where an evaluator simulates a gesture and the patient has to recognize if the gesture was correct or not (all of them have some error of apraxia). The third factor is the performance of serial or sequential action, when the ability to perform gesture implying more than one independent movement to complete an activity or complex gesture is compromised or impaired; this is composed of four items of a sequence of gestures and one gesture imitation. The fourth factor is the recognition of object/tool function, whereby patients see or have the real object and they have to recognize the function of an instrument or carry out an action. The fifth factor refers to gestures or movements representing the use of the object/tool; after a verbal command, patients have to reproduce movements or gestures as if they had the object or tool in their hands. The sixth factor is gesture imitation of complex movements after seeing the movement in the examiner. The seventh factor is the good-bye gesture, where the patient has to perform the gesture after listening to the command. The eighth factor is the complex sequence of two-finger positions, whereby the patient has to make a gesture imitation of a chain, formed by the thumbs and forefingers of each hand. Finally, the ninth factor is the performance of routine gestures, where the patient has to perform two common or everyday gestures. Table I shows the nine factors of the EULA test with each corresponding item.

The 32 items were grouped according to the praxis function examined to facilitate the administration. The instructions were related to imitation gestures (transitive and intransitive), performance of gestures after a verbal command (transitive and intransitive), recognition of gestural action, discrimination of gestural errors, description of the function of a real object, performance of a gestural action. The EULA test is shown in Table II.

Laboratory methods

The patients with CCI were assessed in one of the doctor's offices in the Dementia Care Unit of the Hospital Virgen de las Nieves in Granada. The room used for the evaluation had sufficient light, a comfortable temperature, and a low level of environmental noise. As part of the standard protocol in this unit, the cognitive functions of each new outpatient are integrally assessed with the SCA as well as by means of a neurological exploration in those cases in which such procedures are viable. In addition to the SCA and the neurological exploration, the patients in the cognitively impaired group were also assessed with the EULA. Two paper copies were made of the results recorded for each participant. As previously mentioned, the patients had received information regarding the study and their written informed consent had been obtained. In those cases when this was not possible, informed consent was obtained from family members or caregivers (legal tutor). The overall assessment of each patient was performed by different examiners, who had no knowledge of the patient's score in the other tests.

In contrast, the subjects in the control group were evaluated in a room in their own homes, which had environmental and physical conditions as similar as possible to those at the doctor's office. After informing the subjects of the nature of the study and obtaining their informed consent, they were given the EULA test and the Phototest, and their sociodemographic data were recorded. All of the data for both groups were collected in one session.

Statistical analysis

Both a descriptive analysis and a frequency analysis were applied to the sample. In order to show the structure of the EULA test, we performed an exploratory factor analysis with varimax rotation. The factors were selected by applying the Kaiser rule and by analyzing the scree plot. When the internal validity of the test was confirmed, its reliability was tested by calculating Cronbach's alpha and using one of the methods based on the division of the test into two halves, with the Guttman's formula. This method involves a single administration of the instrument and after dividing the test into two parallel halves (pair items vs. odd items).The construct validity was also calculated by carrying out two Pearson's bivariate correlations between 9 factors resulting from the factor analysis of the EULA test and the SCA apraxia subscales. The first correlation

Table II. EULA test for the evaluation of upper limb apraxia and instructions.

The patient should imitate the following gestures	Left hand opened and right hand closed
	Opposition of the index and little fingers
	Hands perpendicularly to each other
	Hands butterfly shaped
	Gesture of two rings chains, formed by the thumb and forefinger
	Gesture of opening a bottle of water
	Gesture of 'driving a clove with a hammer'
	Gesture of drinking a glass of water
	Gesture of open a bottle of wine
The evaluator should verbally request the following gestures	Make the gesture of asking about: 'How much does something cost?'
	Make the gesture of being crazy
	Make the gesture of scolding someone
	Perform the good-bye gesture
	Say with your hand 'Come here!' or make gesture of calling someone
	Make the gesture of filling a glass of water
	Act as if would spread butter on toast
	Act as if would introduce a letter in an envelope and would put a stamp
	Act as if would light a candle, with a match inside a box
	Act as if would put toothpaste on a toothbrush and brush your teeth
	Make as if would cut a paper with scissors
	Make as if would drive a clove with a hammer
	Make as if would move a coffee with a teaspoon
The patient should recognize the action after observing the gesture performed by the evaluator (without object)	Recognize the simulation of sawing with a saw after see the performing of the evaluator
The patient should recognize if the gesture is correct or not	Use fingers like a toothbrush
	Use thumb and forefinger like scissors
	Use a finger as a screwdriver
	Use a fist as a hammer
	Increase the movement of moving the coffee, and using a finger as a teaspoon
The patient should describe the function of a real object	A match
	A shower sponge
The patient should perform an action/gesture with a real object	Putting a clinical robe
	Buttoning a button of the clinical robe
Total score	

The punctuation is scored by a Likert scale from 0 to 2 points. A punctuation of 0 means that the patient has not performed the gesture or the gesture is not recognized by the evaluator; 1 means that the gesture is recognizable but is not totally correct, i.e. the patient has some apraxic error (spatial, temporal, content or using a part of body like an object); and 2 points when the gesture is correct, without any error. The total score is 64 points.

was calculated between each of the 9 factors of EULA test and the total score of visual construction subtest; the second correlation was made between each of 9 factors of EULA test and the total score of motor apraxia subtest. Finally, we calculated the total means and the means of each group in the EULA test in order to compare the scores of the group of subjects with CCI with the scores of the subjects in the control group.

Results

Description of the sample

The participants in the study were 57 patients with CCI and 39 healthy subjects. For sociodemographic data, the mean and standard deviation of age for subjects with CCI was 75.05 ± 8.5, for healthy subjects was 61.21 ± 10.45. Female prevalence in subjects with CCI was 56.1% and for healthy subjects was 71.8%. 31% subjects with CCI didn't have none years of schooling, 22.8% over 5 years, 24.6% between 5 and 10 years, 15.8% over 10 years, and 31.6% no schooling; for healthy subjects, 5.7% didn't have none years of schooling, 22.9% over 5 years, 25.7% between 5 and 10 years, 45.7% over 10 years, and 8.6% no schooling. For educational level, sample with CCI that unfinished primary school was 33.3%, primary school 21.1%, secondary school 3.5% and associate's degree 5.3%; sample of healthy subjects that unfinished primary school was 34.3%, primary school 8.6%, secondary school 14.3%, associate's degree 22.9% and graduate 11.4%. In sample with CCI, 14% of subjects were illiterate, 36.8% reads and writes with difficulty and 43.9% reads and writes well; in sample of healthy subjects, 5.7% were illiterate, 28.6% reads and writes with difficulty and 65.7% reads and writes well. Hemispheric dominance prevalence in subject with CCI was 93% with right-handed and 1.8% left-handed. Hemispheric dominance for healthy subjects was 91.9% with right-handed, 2.7% left-handed and 5.4% ambidextrous.

For clinical data of subjects, Phototest total scores for healthy subjects was an average of 43.13 ± 6.59 (cut point of 28-29 for cognitive impairment detection).

Mean and standard deviation scores in SCA for subjects with CCI were 8.94 ± 3.99 in total learning curve (maximum score 30), 6.26 ± 1.23 total digits (maximum score 15), 9.20 ± 2.15 naming (maximum score 15), 8.22 ± 1.96 comprehension (maximum score 10), 8.80 ± 3.79 semantic verbal fluency, 4.42 ± 1.72 similarities (maximum score 10), 5.59 ± 2.87 calculation (maximum score 10), 9.78 ± 1.9 motor apraxia (maximum score 12), 5.45 ± 2.47 visual construction (maximum score 10), 0.71 ± 1.34 memory (maximum score 10), 13.91 ± 2.83 recognition (maximum score 20), and 3.92 ± 2.8 discrimination (maximum score 10).

Structure of the EULA: factor analysis

An exploratory factor analysis with varimax rotation was performed on the test items in order to verify the structure of the instrument and its domains. The factors were selected by applying the Kaiser rule, retaining factors with an eigen value greater than 1, and by analyzing the scree plot. This resulted in nine factors, which explained 69.91% of the total variance of the data. Table III shows the results of the factor analysis.

Reliability of the EULA

The results obtained show the high level of reliability of the EULA as reflected in a Cronbach's alpha of 0.929 and a Guttman's split-half coefficient of 0.870.

Construct validity

The construct validity of the EULA was measured by means of Pearson's bivariate correlations between the 9 factors of EULA and the subtests of SCA (visual construction and motor apraxia) as shown in Table IV. The results indicated that there is a significant correlation between the SCA subscales and factors 1, 3, 4, and 9. In addition, the motor apraxia subscale correlates with factor 8 and the visual construction subscale with factor 5.

Means of both subject groups

Table V shows the mean EULA score values obtained by both groups.

Discussion

In the specialized literature on apraxia, there is no clear consensus of opinion at the theoretical-conceptual level. As a result, authors find it difficult to agree on which aspects of this syndrome should be measured and assessed. Precisely for this reason, there are few tests that can be used to effectively evaluate upper limb apraxia, especially for the Spanish-speaking population. As part of this research, we elaborated a test for the evaluation of upper limb apraxia (EULA), which was designed as a pilot study of two groups of Spanish-speaking subjects, CCI population and health subjects.

Table III. Factor matrix of the nine factors of EULA test as result of the exploratory factorial for total sample.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
Item 1	*0.530*	–0.009	0.455	0.214	0.247	0.216	–0.002	0.233	0.104
Item 2	*0.665*	0.228	0.228	0.146	–0.054	0.238	0.209	0.044	0.102
Item 8	*0.584*	0.266	0.017	–0.070	0.035	0.077	0.200	0.477	0.280
Item 11	*0.482*	0.237	0.142	0.259	0.325	0.144	0.364	0.106	0.085
Item 12	*0.586*	0.196	0.307	0.002	0.405	–0.019	–0.029	–0.137	0.088
Item 13	*0.622*	0.077	–0.169	0.127	0.304	0.229	0.324	–0.171	0.102
Item 20	*0.680*	0.252	0.102	0.171	0.152	–0.006	–0.137	0.077	0.003
Item 41	*0.669*	0.169	0.286	0.088	0.109	0.186	–0.070	0.088	0.143
Item 23	0.275	*0.749*	0.113	0.214	0.033	–0.010	0.273	0.074	0.036
Item 24	0.330	*0.728*	0.161	0.148	0.079	0.072	0.068	0.057	0.002
Item 25	0.132	*0.750*	0.117	0.133	0.252	0.170	–0.016	–0.187	0.233
Item 26	0.354	*0.734*	0.039	0.098	0.159	0.015	0.119	0.077	–0.125
Item 27	–0.131	*0.660*	0.273	0.227	0.068	0.193	0.189	0.224	0.062
Item 3	0.168	0.106	*0.576*	0.232	0.092	0.375	–0.080	0.183	0.140
Item 15	0.180	0.451	*0.509*	0.044	0.302	–0.097	–0.066	0.078	0.123
Item 38	0.043	0.236	*0.538*	0.097	0.034	0.255	0.252	0.180	–0.157
Item 39	0.267	0.288	*0.618*	0.214	0.099	0.000	0.316	0.134	0.027
Item 40	0.212	0.123	*0.712*	–0.158	0.167	0.031	0.101	–0.160	0.173
Item 19	0.179	0.284	–0.067	*0.701*	0.036	0.037	–0.242	–0.097	0.007
Item 21	0.051	0.108	–0.044	*0.708*	0.063	–0.012	0.163	–0.084	0.069
Item 22	0.150	0.031	0.012	*0.546*	0.079	0.535	–0.127	0.229	0.127
Item 36	0.140	0.127	0.211	*0.727*	0.027	–0.001	0.213	0.391	–0.075
Item 37	0.072	0.116	0.458	*0.670*	0.092	–0.012	0.015	0.134	–0.093
Item 16	0.230	0.217	0.136	0.017	*0.807*	0.021	–0.057	–0.037	0.032
Item 17	0.221	0.079	0.124	0.185	*0.675*	0.398	0.146	0.231	0.049
Item 18	0.079	0.128	0.284	0.142	*0.561*	–0.052	0.394	0.243	0.115
Item 4	0.036	0.513	0.204	–0.099	–0.046	*0.558*	–0.069	0.135	0.051
Item 6	0.443	0.087	0.134	–0.008	0.131	*0.683*	0.103	–0.041	–0.149
Item 9	0.037	0.203	0.121	–0.005	0.043	–0.006	*0.769*	–0.086	0.034
Item 5	0.069	0.089	0.105	0.088	0.101	0.070	–0.101	*0.854*	–0.017
Item 7	0.172	0.068	0.106	0.016	0.060	–0.030	0.027	0.052	*0.908*
Item 10	0.180	–0.016	0.295	0.284	0.286	0.323	0.376	–0.105	*0.404*

It were selected and it was shown domain-relevant factor weights with an absolute value greater than 0.4. Items are shown in Table I.

Table IV. Construct validity of the EULA test. Pearson's bivariate correlation between each of nine factors of EULA and SCA subtest of apraxia.

	Visual construction subtest (*r*)	Motor apraxia subtest (*r*)
Factor 1	0.422 [a]	0.285 [b]
Factor 2	0.225	0.254
Factor 3	0.453 [a]	0.520 [a]
Factor 4	0.302 [b]	0.345 [b]
Factor 5	0.325 [b]	0.261
Factor 6	0.086	0.141
Factor 7	0.086	0.141
Factor 8	0.236	0.342 [b]
Factor 9	0.278 [b]	0.365 [a]

r: Pearson correlation of the EULA test factors with the SCA visual construction and motor apraxia subscales. [a] $p < 0.01$ (bilateral); [b] $p < 0.05$ (bilateral).

Table V. Mean EULA score values obtained for all subjects and for each group. Comparison of scores obtained by cognitively impaired subjects and by healthy subjects.

	Total sample Mean (CI)	Subjects with CCI Mean (CI)	Healthy subjects Mean (CI)	*p*
Factor 1	11.49 (2-16)	9.1 (2-16)	14.9 (9-16)	0.000 [a]
Factor 2	6.37 (0-10)	4.8 (0-10)	8.6 (3-10)	0.000 [a]
Factor 3	7.12 (1-10)	6.4 (1-10)	8.1 (5-10)	0.000 [a]
Factor 4	9.29 (0-10)	8.8 (0-10)	9.9 (8-10)	0.002 [a]
Factor 5	5.05 (1-6)	4.6 (1-6)	5.7 (4-6)	0.000 [a]
Factor 6	1.8 (0-2)	1.7 (0-2)	1.9 (0-2)	0.057
Factor 7	1.8 (0-2)	1.7 (0-2)	1.9 (0-2)	0.057
Factor 8	1.9 (0-2)	1.9 (0-2)	1.97 (1-2)	0.091
Factor 9	3.64 (0-4)	3.45 (0-4)	3.9 (3-4)	0.003 [a]

CCI: complain of cognitive impairment; CI: confidence interval; *p*: significance between groups. [a] Significant differences ($p < 0.05$).

The EULA test result shows that this is an easy tool to assess and evaluate upper limb apraxia, with relatively high levels of scientific validity. The internal consistency and structure of the EULA test was assessed by using a series of statistical analyses similar to those used in two other research studies that evaluated apraxia with a battery of tests for gesture production [11,21]. The results of the analysis were satisfactory. The EULA was found to have remarkable reliability and a solid internal structure. EULA showed construct validity since there was a significant correlation between six of the nine factors in the EULA and the two SCA subscales, which also measure upper limb apraxia. In all likelihood, the three factors without significant correlation are not measured on the SCA subscales and belong to the praxic subfunctions of semantic storage necessary to know whether a certain gesture is correct, say goodbye with gestures, and for the imitation of gestures.

Previous tests on upper limb apraxia have been focused in a specific function of apraxia syndrome as isolate. In our concern, the EULA test is the first tool to assess this syndrome in a multifactorial approach since it contains items that include the majority of functions that should be evaluated for upper limb apraxia and it involves several neural networks identified in the praxis function. Therefore, the test includes a total of six sub-functions of apraxia implicated in the theoretical cognitive models. First subfunction is gestures imitation, transitive and intransitives; secondly, through verbal command, production of transitive and intransitive gestures; thirdly, recognition of gestures produced by the evaluator; fourthly, recognize if a gesture produced by evaluator is correct or if he/she is performing some apraxia error, for example, using a part of the body as a tool; fifth, describe the function of a real object after see it; and finally, using a real object without apraxia errors.

The EULA test could be used in several areas of health sciences. First, could be used by physicians as neurologists, to assess this type of apraxia and to measure the follow up of the patient with cognitive impairment. Secondly, could be used by rehabilitation professionals to evaluate the improvement after a rehabilitative intervention whereby the measures pre and post-intervention and as a future guideline to design the interventions of rehabilitation. Finally, the test could be utilized for research in studies of effectiveness of pharmacologic and no pharmacologic treatments.

In reference to the first factor of the EULA (gesture production by imitation and verbal command), in a previous study, the lowest mean values were obtained by patients probably suffering from Alzheimer's disease in comparison to the control

group of subjects without cognitive impairment. In a cohort of subjects with Alzheimer's disease, it was found that the third factor of this test in itself effectively measured upper limb apraxia [13].

The mean EULA scores for subjects of both groups can orient the physician regarding how to adjust the test by comparing the results of the patient to see whether his/her score is closer to the mean of the cognitively impaired subjects or to the mean of the healthy subjects. Another research study administered an upper limb apraxia test, similar to the EULA, but with different items that assessed other praxic aspects. The test was given to the following population samples: subjects with cognitive impairment, subjects with no cognitive impairment, and subjects with dementia. The results obtained confirm those in this study in which the differences between the scores of the healthy subjects and those with CCI are statistically significant. It also identified apraxia in dementia patients [15].

Another study describes an upper limb apraxia test for the detection and disaggregation of specific praxic disorders, based on the cognitive model of González-Rothi et al. [9] as modified by Cubelli et al. [22]. This study resembles ours but it has different items and the subjects were patients with ischemic and hemorrhagic cardiovascular accidents and primary degenerative dementias. For all the tests in the battery, the patients with brain damage performed significantly worse than the control group of healthy subjects [10].

Since the EULA is still in the pilot phase, one limitation is that the test should only be administered to patients with CCI so that the data can be compared with the mean values obtained in this study. However, the results so far are promising as reflected in the research described in this paper. This findings highlight the EULA's potential as an instrument capable of effectively differentiating patients with apraxia from those that do not have this disorder. Future research could be lead to validate the test in populations with cerebral damage.

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Creación y diseño de un test para la evaluación de la apraxia de los miembros superiores (EULA) basado en un modelo cognitivo: un estudio piloto

Introducción. La apraxia es un trastorno neurológico caracterizado por la dificultad en la ejecución de habilidades gestuales aprendidas a pesar de tener preservados los sistemas motores y sensoriales, la coordinación y la comprensión, así como de una adecuada colaboración. Actualmente, existen pocas herramientas validadas que evalúen este síndrome de manera global. En el presente estudio, se ha creado y diseñado un test para la evaluación de la apraxia de los miembros superiores (EULA), basado en modelos teóricos.

Sujetos y métodos. Se seleccionó una población de 57 pacientes con quejas subjetivas de deterioro cognitivo y 39 personas sin quejas ni deterioro cognitivo, a las cuales se les administró el test EULA, entre otros tests. Se realizó un análisis factorial de componentes principales y un cálculo tanto de la fiabilidad como de la validez de dicho instrumento.

Resultados. El análisis factorial agrupó en nueve factores todos los ítems de la prueba, con una varianza total explicada del 69,91%. El test ha mostrado una alta fiabilidad, con un alfa de Cronbach de 0,929 y un coeficiente de Guttman de 0,870 con el método de las dos mitades. El test también mostró tener una adecuada validez de constructo, al existir correlación significativa entre seis factores del test y dos subtests de apraxia.

Conclusiones. El test EULA, surgido de las propuestas de evaluación a nivel teórico desarrolladas por diferentes autores, muestra una puntuación superior en personas sanas respecto a personas con manifestaciones subjetivas de deterioro cognitivo, además de tener una alta fiabilidad y validez de constructo.

Palabras clave. Apraxia. Apraxia de miembros superiores. Deterioro cognitivo. EULA. Evaluación. Test.