ORIGINAL ARTICLE

Validation study of the Italian version of Communication Activities of the Daily Living (CADL 2) as an ecologic cognitive assessment measure in older subjects

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Abstract

Introduction Communication can be affected by age related cognitive decline and mental deterioration. The second edition of the Communication Activities of the Daily Living (CADL 2) appears as an interesting ecological assessment tool of cognitive functions in old age.

Objective The aim of this work is to (1) develop an Italian version of CADL 2, (2) to test its psychometric properties in terms of reliability and validity, and (3) to measure CADL 2 discriminative capacity between cognitively healthy and cognitively impaired older subjects.

Method One hundred and eleven subjects were enrolled (36 M; 75 F, age 80, 80.85 ± 7 years, education 9.3 ± 4.7 years). The CADL 2 was administered together with a standard neuropsychological battery.

Results The CADL 2 showed good reliability and correlates with all the cognitive evaluation tests. The CADL 2's area under the curve was equal to 0.80, index of good diagnostic accuracy.

Conclusions The CADL 2 is an appropriate assessment tool for communication skills in aging.

Introduction

The worldwide aging of the population is an important demographic phenomenon characterized by an ever-increasing number of the oldest old (over 80 years), a group particularly at risk of cognitive impairment and sensorineural defect, conditions with a great impact on communication skills.

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However, the research on brain and cognitive reserve indicates that genetic and environmental factors [1, 2] interact in determining a resilience against vascular, traumatic, or degenerative damage in the course of life. Numerous studies agree on the existence of a neurofunctional reorganization in aging, which allows preserving most of the communication skills [3].

The language is a complex and fundamental faculty of human communication, supported by dynamic interactions between ad hoc neural networks. Most of the processes of understanding remain substantially stable throughout life, although physiological aging affects some aspects of linguistic production [4]. Communication represents a very important aspect of life, and it has been defined the "behavior that takes place when two or more people define their relationship" [5]. In this perspective, "the aging person is an active participant in a system of relationships, constantly trying to adapt and maintain a relational balance" [5].

Language deficits appear in early stages of Alzheimer's dementia and represent the prevailing symptom in variants of primary progressive aphasia; moreover, non-verbal communication is preserved also in severe cognitive impairment [6].

In studies on persons with severe dementia, the conversational abilities are described as relatively preserved in terms of exchange of words, in spite of the disappearance of the communicative function (exchange of meanings) [7]. Repetitive questions, word-finding difficulties, lack of conversation, and difficulties into recount recent activities are referring as problematic aspects in communication by family caregiver of persons with dementia [8]. Moreover, studies on pragmatic and social functioning in dementia, summarized by Cummings [9], include pragmatic and discourse difficulties, referential communication disturbances, impaired comprehension of indirect requests, topic management deficits, and interpretation of sarcasm deficits.

Consequently, in addition to the assessment of formal aspects of language (phonological, lexical, and grammatical domains), the pragmatic and functional communication assessments are particularly salient in aging.

Pragmatic was defined as an appropriate use of language across a variety of social contexts that provides accurate interpretation of intentions and references [10]. It is linked to communicative proficiencies and it is a real-time behavior that requires the following: (1) linguistic knowledge (syntax, semantic and phonology); (2) knowledge of objects, events, and actions; and (3) social knowledge [10].

Functional communication was defined as the ability to communicate effectively and independently in relevant life situations [11].

Both pragmatic and functional communication depend mainly on attention and executive functioning: two cognitive functions particularly affected by cognitive aging as Salthouse and colleagues stated [12].

Besides, on one side, the loss of pragmatic communication skills reduces individual's ability to effectively convey his needs, and to elicit help from others [10], on the other, the impairment on functional abilities impacts on quality of life [11].

The International Classification of Functioning, Disability, and Health (ICF) of the World Health Organization (WHO) highlights how various components interact into determinate the functioning in communication. The anatomical–physiological changes due to the aging process (body functions and structures) affect how the persons perform the activities and how they can take part in the circumstances of life (activity and participation). At the same time, the characteristics of the physical environment and the attitudes of people (environmental factors) that surround the person can facilitate or, on the contrary, hinder communication. Finally, even the beliefs and opinions that the person has about himself and the environment that surrounds it (personal factors) exert an influence.

Let us begin, for example, with an impaired hearing elderly man: he will have difficulty in undertaking a conversation, especially in a noisy environment, such as a family lunch. The possibility that he participates in the speeches will depend on the attitude of the family members: they can dispose in a way that facilitate lip reading or raise the volume of their own voice. At the same time, his availability to wear a hearing aid, his motivations, and his beliefs respect to the possibility of participating are very important. His desire to share own experience and to listen to what is said will sustain him to become active in different ways in the situation.

A similar reasoning can be applied in the case of the person with cognitive impairment.

The basic assumption of the ICF is that all components of the operation have the same weight and interact with each other so that people with a similar cognitive profile can have a very different functioning in everyday life and this has a very important fallout on the possibility of undertaking intervention strategies and submit them to verification of effectiveness.

However, the ICF implementation in geriatric domain is scarce [13] and literature dedicated to communication abilities on daily living in dementia is very limited. Byrne and Orange [8] provided a description of the ICF as it relates to the language and communication changes experienced by individuals with dementia reporting that the body functions of the ICF framework relevant to the communication and language changes regard mental functions as memory, attention, executive functions (e.g., planning and carrying out tasks), critical thinking, and language, among others.

Moreover, the age itself may affect pragmatic features of verbal communication in cognitively normal older people [14] consistently with the cognitive changes observed in normal aging [15], and this may explain the central role of the cognition on communication also in not pathological conditions.

As previously stated [16], the cognitive assessment in aging is characterized by some critical issues that include the following: (1) inadequate stimuli (i.e., small visual stimuli), (2) lack of normative data, (3) lack of specific tools for elderly people especially in the case of oldest old, (4) poorly motivating assessment procedures (i.e., tasks are perceived as strange or unfamiliar), and (5) a limited respect to elderly people attention's times (i.e., too long batteries). All this entails the risk of collecting data that are scarcely representative of real abilities of the persons in everyday life.

This observation supports the need of cognitive tests with high ecological validity that is defined as "functional and predictive relationship between the patient's performance on a set of neuropsychological tests and the patient's behavior in a variety of real world settings" [17].

The neuropsychological assessment is more useful if it is able to return an image of the functional status of the subject, thus requiring tasks similar to those of daily life (verisimilitude approach) or tests scores related on other measures that predict real world performance (veridicality approach) [18, 19].

All this considering, between the communication abilities assessment tools, the Communication Activities of Daily Living—Second edition (CADL 2) [20] could be considered as an ecologic test and it is recently categorized as an instruments for adult pragmatic and functional assessment [10].

The CADL 2 assesses the functional communication skills of adults with neurogenic communication disorders. It is focused on the communicative performance during the performance of different activities.

It originates from the theoretical context of sociolinguistic theory and the holistic structure of functional communication, both oriented to assess cognitive aspects within a context. The CADL 2 proposes to assess communication abilities in activities of daily living through communication acts' simulation in hypothetical natural environments.

As both aging and cognitive impairments can disrupt communication abilities, the rationale of our study is to explore the potentiality of an ecologic assessment tool of communication abilities in activities of daily living. In particular, our interest is in how and what extent is the difference between cognitive normal individuals and individuals with cognitive impairment.

The present study, grounded on a biopsychosocial view of health, and stemming from the need of taking into account the ecological validity in the choice of the tools of cognitive assessment of the elderly, proposes an Italian version of the CADL 2 with the first aim to make available an ecological communicative abilities assessment tool for this population.

The second aim is to study the CADL 2 ability to differentiate healthy aging from cognitive impairment.

Subjects and method

The present study was performed in accordance with the Helsinki Declaration. All participants gave their informed consent to participate.

Cognitively normal persons (CTL) and persons with cognitive deficits (DET) were recruited on a voluntary basis (September 2011 to June 2016) from the Geriatrics and Gerontologic Section of University of Perugia, the Intensive Care and Geriatric Medicine Division of Careggi Hospital in Florence, the Geriatric Unit at the University of Milan, and from elder social centers and community.

Inclusion criteria were as follows: (a) no history of traumatic brain injury, (b) no history of stroke, (c) no history of neurological disorders, (d) no history of psychiatric disorders, and (e) no clinical evidence or history of depression.

The inclusion criteria (a)–(e) were assessed by a brief interview.

In order to avoid selecting a sample of "supernormal" subjects, we did not exclude individuals with pharmacological well-compensated hypertension, diabetes, and anxious/depressive symptoms and corrected sensory deficits were allowed.

To form the cognitively healthy group, a detailed assessment was carried out using an extensive battery of measures (functional and cognitive) (Table 1). For the oldest old, minimal supervision at the basic activities of daily living or minimal disabilities in instrumental activities of daily living, due to physical problems, was allowed.

CTL included subjects with an age–education corrected Mini Mental State Examination (MMSE) score ≥ 26 and a Clinical Dementia Rating Scale (CDR) score $= 0$.

DET included persons with cognitive impairment diagnosis formulated according to international criteria [21, 22].

Italian version of CADL 2

The Italian CADL 2 derives from Communicative Abilities in Daily Living [23, 24] and assesses the communication abilities in different everyday life contexts. With respect to the first version, it was modified by eliminating items that require a role-playing, those that appear suitable only to certain people (for example, suitable for a certain age group but not to others), and, finally, those redundant. Furthermore, it was published with the term "activities" instead of "abilities" in the title, converging with the WHO's perspective to prefer the use of "activity limitation" to "disability" and "communicative activities" to "communication skills." The CADL 2, although shorter than CADL, maintains the same sensitivity in identifying 7 relevant categories of functional communication:

1. Reading, writing, using numbers (26 items). This category includes items that reflect basic skills in a variety of context-decoding tasks or that require calculations based on skills numerical (e.g., to identify the date, calculate the expenditure).
2. Social interactions (18 items). This new category was created by bringing together the categories Social Conventions and Linguistic Acts. It includes items that link exchanges in which speech, gestures, or written information are used to provide both information and intentions (e.g., to correct, to make inferences, to ask for clarification, to ask to repeat, to express thank).
3. Divergent communication (10 items). It concerns items regarding the generation of logical alternatives from a given information and the readiness to vary the response's orientation. (i.e., the examinee indicates the best time to have lunch)
4. Contextual communication (10 items). It includes items that require an analysis of the contest (i.e., to decide what to wear on a rainy day).
5. Non-verbal communication (8 items). It concerns items concerning non-verbal communication and communicative

Table 1 Employed measures

Domains	Measures	Lower score interpretation	Range scores	References Italian version
Activity of Daily Living	Activity of Daily Living Scale (ADL)	Worst performance	0–6	Katz, Ford, Moskowitz, Jackson, & Katz, 1963
Instrumental Activity of Daily Living	Instrumental Activity of Daily Living Scale (IADL)	Worst performance	0–8	Lawton & Brody, 1969
Global cognition	Addenbrooke's Cognitive Examination Revised (including MMSE)	Worst performance	0–100 scores	Pigliautile et al., 2012
Attention	Attentional Matrices	Worst performance	0–30 scores	Spinnler and Tognoni, 1987
	Trail Making Test A	Best performance	0–300 (time in seconds)	Amodio et al., 2002
Executive Functions	Trail Making Test B	Best performance	0–300 (time in seconds)	Amodio et al., 2002
	Verbal judgments	Worst performance	0–60 scores	Spinnler and Tognoni, 1987
Memory	Digit Span Forward	Worst performance	No range	Monaco et al. 2013
	Digit Span Backward	Worst performance	No range	Monaco et al. 2013
	Corsi's Span	Worst performance	No range	Monaco et al. 2013
	Rey Auditory Verbal Learning Test Immediate and Delayed recall	Worst performance	0–75 scores	Caltagirone et al., 1995; Carlesimo et al., 1995; 1996
	Babcock story recall	Worst performance	0–16 scores	Spinnler and Tognoni, 1987
Language	Verbal fluency/letter	Worst performance	No range	Caltagirone et al., 1995; Carlesimo et al., 1995; 1996
	Verbal fluency/category	Worst performance	No range	Spinnler and Tognoni, 1987
	Token test	Worst performance	0–36 scores	Spinnler and Tognoni, 1987
Intelligence	Raven's Colored Progressive Matrices	Worst performance	0–36 scores	Caltagirone et al., 1995; Carlesimo et al., 1995; 1996

symbols or behaviors related to the movement or that depend on the movement (i.e., to use a map).

6. Sequential relationships (6 items). To investigate the ability to undertake behavioral sequences such as making a phone call and disentangling cause–effect situations (e.g., to identify where an article is placed between the lanes of a food store).

7. Humor/metaphor/absurdity (3 items). This category presents a humoristic situation, metaphor, and an absurdity and requires a high degree of cognitive processing.

The CADL's scoring system (correct = 2 points, adequate = 1 point, incorrect = 0 points) is maintained in CADL 2 and it emphasizes the idea that a message can vary in a continuum from correct to incorrect.

The CADL 2 was translated and adapted into Italian. Items containing images have been modified or recreated through a computer program, in order to obtain meaningful images for Italian people. For example, the item in which the examinee must choose a jar of peeled tomatoes among four distractors (jar of diced pulp, jar of lentils, jar of tomato paste, and bottle of tomato puree) has been entirely recreated respecting the form and content of the original image but inserting products of Italian brands. The same procedure was performed in all similar cases (medicines, household products, drinks). The item that provides the image of a menu has been adapted by inserting breakfast foods compatible with Italian culture (cappuccino and croissant instead of breakfast). Moreover, in an image containing road signs, instead of those used in US culture, European ones have been inserted. The image of the item taken from the "Yellows Pages" has been replaced with an image taken from the "Yellow Pages" of an Italian region. Where the original image appeared appropriate to the Italian context and culture, if present, only the written parts were adapted.

For example, an item shows a food shop in which the examinee must indicate in which of the four lanes he would look for a notebook: all the words, written in the image, have been translated into Italian and inserted keeping the same graphic style of the original. All references to the dollar have been changed to Euro. Finally, an item that proposes a phone call to the "correct time" service number was replaced by a call to a similar service of an Italian telephone company. The task consists in composing the number and report the answer to the examiner. If the telephone line has some problems, it is considered correct response if the subject reports the voice message of "non-existent number."

Actually, the Italian version of the CADL 2 is available by contacting the authors exclusively for research scope.

Statistical analysis

Statistical Package for Social Sciences 17 (SPSS Statistical Package for Social Sciences - SPSS Inc., Chicago, IL) for Windows was used.

The reliability of the Italian CADL 2 was measured in terms of internal consistency using Cronbach's α coefficient. Evidence of concurrent and convergent validity were provided computing Pearson's correlation coefficients between CADL 2, and all the cognitive measures were considered.

Receiver operating characteristic curve (ROC) analysis was applied to define sensitivity and specificity of CADL 2 to differentiate CTL from DET.

Results

The study included 111 (45 women, 66 men) participants with a mean age of 80.85 (SD = 7.45, range 62–93, Sk = − .53, Ku = − 44) and a mean of years of schooling of 9.26 (SD = 4.74, range 0–18, Sk = .99, Ku = − .46). Demographic and neuropsychological characteristics of the sample are reported in Table 2.

The Cronbach's α coefficient for the Italian CADL 2 was .914, an excellent result in terms of internal consistency [25].

Correlation's analysis reveals that the Italian CADL 2 correlated with all the employed measures as reported in Table 3.

ROC curves demonstrated that the Italian CADL 2 (AUC 0.798; 95% CI = 0.706–0.890) discriminates CTL from DET (Fig. 1).

Discussion

The diagnosis of the disease is not useful to understand the abilities of people with dementia in daily life. At the same time, there are factors that can act as a barrier, preventing the person with disabilities to take part fully in the community life or, on the contrary, as a resource, representing a facilitator for the person.

Since cognitive assessment is an important domain of the Comprehensive Geriatric Assessment [26], it is important to use tools able to return a cognitive profile consistent with the functional status, considering the capabilities of the subject in real life.

This goal can be achieved using assessment tasks similar to daily life activities, especially for older adults who, having sensory deficits and reduced attentional skills, need to be assessed quickly but accurately, in order to obtain reliable evaluation, useful to support the diagnostic and rehabilitation process and to discriminate between cognitively normal older individuals and older individuals with cognitive impairment.

The CADL 2 is an "ecological" test that, involving the examinees in practical activities, seems suitable to evaluate elderly people. The analysis of psychometric properties of the Italian version of CADL 2 shows an excellent reliability (alpha Cronbach's α coefficient equal to 0.92) [27].

The analysis of the convergent validity shows that the CADL 2 significantly correlates with the measures of global cognitive functioning and with those of functional state.

At the same time, there is a significant correlation with all the cognitive measures considered: a not surprising aspect considering that CADL 2 involves the examinee in situations of communication and common tasks of daily life in which executive functions, attention, memory, and language are involved. This data support the validity of construct, since communication is a behavior that involves all cognitive abilities. As it has been recently demonstrated, beyond clinical conditions such as aphasia or brain trauma, Parkinson's disease, which involves the frontal lobes, also determines deficits in the pragmatic aspects of communication [28].

The CADL 2 has been employed in the following settings: evaluation of cognitive pragmatic treatment programs [29], communication disorders diagnosis [30], investigation of the daily talk time of people with non-fluent aphasia and non-aphasic peers [31], assessment of everyday language abilities in subjects with poststroke language disorders and aphasia [32, 33], and evaluation of intensive comprehensive aphasia programs [34].

Table 2 Demographic and neuropsychological characteristics of the sample

	Entire sample		CTL	DET
Sex	$N = 111$ (68% f, 32% m)		$N = 65$ (41% f, 24% m)	$N = 46$ (34% f, 12% m)
	Range	Mean (st. dev)	Mean (st. dev)	Mean (st. dev)
Age	62–93	80.85 (7.45)	79.72 (8.35)	82.43 (5.65)
Education	0–18	9.26 (4.74)	10.42 (4.96)	7.60 (3.89)
CDR	0–2	0.24 (0.35)	0	0.62 (0.27)
MMSEr	15–30	26.70 (3.59)	28.69 (1.36)	23.70 (3.82)
MMSEc	17.20–30	27.02 (3.28)	28.87 (1.40)	24.26 (3.37)
ACE-R	37–98	75.38 (15.81)	84.54 (9.03)	61.67 (13.56)

f female, *m* male, *st dev* standard deviation, *CDR* clinical dementia rating scale score, *MMSEr* Mini Mental Sate Examination row score, *MMSEc* Mini Mental State Examination correct score, *ACE-R* Addenbrooke's Cognitive Examination Revised Score

Table 3 Correlations of the CADL 2 scores with the variables in the study

Measures	M (SD)	CADL 2	CADL 2/CTL	CADL 2/DET
Demographical				
Age	80.85 (7.45)	− .34**	− .566**	.214
Education	9.26 (4.74)	− .57**	.596**	.638**
Global functions				
Addenbrooke's Cognitive Examination Revised	75,44 (15.73)	.801**	.657**	.688**
Mini Mental State Examination	26.70 (3.59)	.791**	.477**	.735**
Functional status				
Activity Daily Living	5.24 (0.90)	.496**	.296*	.498**
Instrumental Activitiy of Daily Living	5.81 (1.92)	.379**	.109	.370
Severity of dementia				
Clinical Dementia Rating Scale	.26 (.41)	− .51**	°	− .171
Attention				
Attentional Matrices	42.53 (11.33)	.751**	.611**	.736**
Trail Making Test A	69.52 (57.34)	− .624**	− .622**	− .489**
Memory				
Digit Span Forward	5.06 (1.08)	.237*	.381**	.167
Backward Digit Span	3.47 (1.02)	.459**	.395**	.391*
Corsi's Span	4.28 (0.96)	.424**	.443**	.295
Rey verbal auditory learning test Immediate recall	32.40 (14.49)	.613**	.633**	.419**
Rey verbal auditory learning test Delayed recall	5.41 (4.35)	.609**	.506**	.410*
Babcock Story Recall	8.22 (4.00)	.598**	.460**	.415*
Language				
Verbal fluency (letter)	27.34 (12.17)	.512**	.451**	.343*
Verbal fluency (category)	17.36 (7.84)	.574**	.554**	.408*
Token test	31.49 (3.36)	.689**	.589**	.562**
Executive functions				
TMT-B Trail Making B	136.56 (72.13)	− .651**	− .679**	− .559**
Judgment and verbal reasoning tests	47.89 (8.60)	.751**	.757**	.750**
Intelligence				
Raven's Colored Progressive Matrices	25.13 (7.51)	.541**	.668**	.420*

M mean, DS standard deviation, CADL 2 CTL and DET scores, CADL 2/CTL CTL scores, CADL 2/DET DET scores

*Correlation is significant at the 0.05 level; **correlation is significant at the 0.01 level; °correlation is missing because, based on the adopted selection criteria; all the CTL group's score were equal to 0
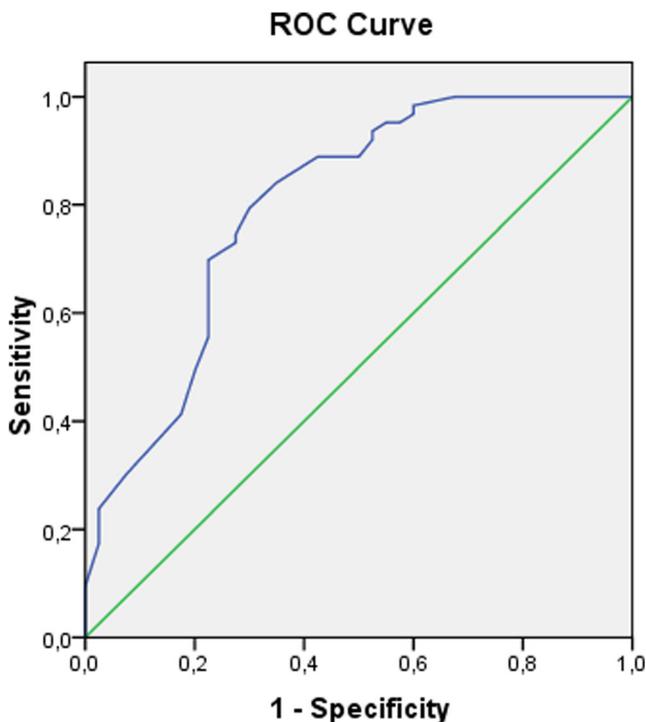

Fig. 1 ROC curves in CTL and DET comparison

For future directions, our data encourage the use of the CADL 2 in the assessment of communication abilities of people with mild dementia. In fact, the impairments of functional communication abilities have a great impact on quality of life [11]. The more a test proposes a familiar task, the more the assessment reflects the functional status of the persons in the real life and the CADL 2 proposes familiar and ecologic tasks. In the present study, the CADL 2 differentiates CTL and DET (mild dementia). Moreover, the CADL 2 had a high correlation with ADL and IADL.

Several limitations should be considered. The first limitation concerns the validation process. It would be interesting to develop a construct validity study of the Italian CADL 2 also by means of correlational studies with similar measures like the Communication Outcome after Stroke (COAST) [11].

Future studies could develop normative data on CADL 2 and compare the performance of different sample of people with communication abilities impairments.

As we illustrated, the CADL 2 is composed by items regarding 7 relevant categories of functional communication (reading/writing/using numbers, social interactions, divergent communication, contextual communication, non-verbal communication, sequential relationships and humor/metaphor/absurdity).

Since recent studies show that different profiles of dementia correspond to different profiles of communication deficits [35], it could be interesting to explore if the CADL 2 supports the differential diagnosis.

From a rehabilitative point of view, an assessment comprehending pragmatic and functional communication abilities, it could be useful to plan "tailored person" stimulation programs. At the same time, the knowledge of the most compromised categories of functional communication seems necessary to build a support environment around the person by means of familiar counseling programs.

Finally, the CADL 2 could be an interesting measure able to capture and assess the results of training programs.

Compliance with ethical standards The present study was performed in accordance with the Helsinki Declaration. All participants gave their informed consent to participate.

Conflict of interest The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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