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Adaptation and normative data for the Comprehensive Aphasia Test in Catalan (CAT-CAT)

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ABSTRACT

Assessment tools for diagnosing aphasia in languages other than English are scarce, particularly for minority languages such as Catalan. The present study introduces the Catalan adaptation of the *Comprehensive Aphasia Test* (CAT-CAT), the first assessment tool of its kind in Catalan, which was developed with careful consideration of cultural and psycholinguistic factors. Additionally, the study provides normative data based on a sample of 110 Catalan-dominant speakers without language or speech disorders in order to establish the range of non-pathological performance and cut-off scores. We also examined the role of sociodemographic factors on language skills in multilingual speakers of a minority language, a topic often overlooked in the literature. Our findings show that subtests evaluating writing skills in Catalan-speaking individuals are less reliable than those assessing oral abilities, as many Catalan speakers have not received formal instruction in their mother tongue. This factor influences performance more than other variables, such as education level. Notably, language-mixing effects from Spanish were observed mainly in specific production subtests. These findings emphasize the need for language-specific adaptations and, therefore, the value of the CAT-CAT as a tool for both clinical and research purposes in aphasiology.

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1. Introduction

Studies examining the linguistic abilities of Catalan-speaking individuals with the purpose to develop an assessment tool to diagnose aphasia are scarce (e.g., Gómez Ruiz, 2008; Lluent Vallet, Peña-Casanova, & Böhm, 2002; Salmons, Muntané-Sánchez, & Gavarró, 2024). The diagnosis of aphasia in Catalan speakers is mostly based on clinical observations,

informal translations of existing tools or through assessment tests in their second language, as there are very few available tools to evaluate the language abilities of Catalan-speaking adults (Bastiaanse, Akinina, Satoer, & de Kok, 2020; Paradis & Libben, 1987; Peña-Casanova & Sánchez Benavides, 2019). These tools were designed for purposes other than diagnosing aphasia, such as evaluating general cognition, and therefore do not specifically target language.

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1.1. Research and assessment gaps

Most studies in aphasiology focus on English, while research on other languages, particularly on minoritized languages, remains limited. For instance, [Egia-Zabala and Munarriz-Ibarrola \(2024\)](#) analysed 307 articles on aphasia published in four peer-reviewed journals indexed in Scopus between 2010 and 2019, and 60.3% of them focused on English speakers. According to the authors, the lack of assessment tools in languages other than English is also one of the causes of limited research on cross-linguistic aphasia. This is also the case for Catalan: despite an increase in the research on the linguistic abilities of Catalan-speaking individuals with aphasia in recent decades, the studies are still limited (among others, [Martínez-Ferreiro, 2010](#); [Salmons, 2015](#); [Gavarró & Dotti, 2014](#); [Peña-Casanova, Diéguez-Vide, Lluent, & Böhm, 2001](#); [Martínez-Ferreiro & Bastiaanse, 2013](#)). Previous studies, however, have argued that assessing patients in their first language improves the accuracy of the diagnosis, even in bilingual speakers. For example, [Kuzmina, Goral, Norvik, and Weekes \(2019\)](#) conducted a systematic review of studies that examined the performance of bilingual individuals with aphasia, and found that the participants performed better in their first language. Interestingly, the structural similarity between languages did not influence the results.

Despite these findings, most available tools for Catalan are direct translations from Spanish or English, which do not take into account relevant linguistic and cultural properties, and none have been standardized. There is abundant literature that points out that psychological tests need to take into account sociocultural factors in order to avoid biases and misdiagnoses (e.g., [Minh Nguyen et al., 2024](#)), particularly with instruments that assess language. Language-specific properties also influence the responses of individuals without disorders, for example, in digit span tasks that assess working memory ([Olazaran, Jacobs, & Stern, 1996](#)), and they can also determine the pattern of impairment in aphasia—for example, the differences in agrammatic production between Semitic and Germanic languages ([Grodzinsky, 1990](#)). It is therefore important to avoid direct translations and instead adapt tests considering the linguistic characteristics of the target language ([Fyndanis et al., 2017](#); [Martínez-Ferreiro, Arslan, et al., 2024](#); [Peña-Casanova, Vinaixa, Diéguez-Vide, Gramunt-Fombuena, & Soler-Campillo, 2022](#)).

1.2. Assessment in minoritized and bilingual contexts

One challenge faced by minoritized languages stems from political and historical contexts, which often lead to language shift and dominance by the majority language. Research frequently reproduces this dynamic. In fact, the few studies on aphasia in Catalan tend to examine it in the context of bilingualism (e.g., [Calabria et al., 2025](#); [Diéguez-Vide, Gich-Fullà, Puig-Alcántara, Sánchez-Benavides, & Peña-Casanova, 2012](#); [Hernández, Caño, Costa, Núria Sebastián-Gallés, & Gascón-Bayarri, 2008, 2010](#)). This tendency is also observed with other minoritized languages in aphasiology: the number of studies on these languages has increased along with the works on bilingualism ([Egia-Zabala & Munarriz-Ibarrola, 2024](#)).

While it is difficult to evaluate Catalan-speaking individuals without acknowledging their bilingual status, studying minoritized languages solely in the context of bilingualism, or only in comparison with the second language, can result in discriminatory practices. Interest in bilingual speakers of minoritized languages rarely translates into the development of psychometric and linguistic measures, or rehabilitation treatments, in the minoritized language, even if it is their first language. This is the case with Catalan, whose use in the health system remains deficient, according to official sources ([Generalitat de Catalunya, 2024](#)), and despite being an official language, with several cases of healthcare professionals discriminating against Catalan-speaking patients ([Parlament de Catalunya, 2025](#)).

Likewise, recent efforts to expand the research and resources for bilinguals in aphasiology have primarily focused on languages spoken by immigrant communities in Western countries, such as Spanish in the United States, with a strong emphasis on sociocultural aspects (e.g., [Watermeyer, 2019](#)). In contrast, speakers of local minoritized languages are often ethnically indistinguishable from speakers of majority languages, partly due to assimilation processes. It is no surprise, therefore, that a minoritized language like Catalan—spoken primarily by individuals who also speak a majority language—is frequently overlooked in clinical contexts, even in the context of speech and language disorders. However, as already argued, previous research underlines the importance of developing tests and normative data that take into account linguistic (and cultural) variables to evaluate and rehabilitate patients in their first language (e.g., [de Mossaic & Bowen, 2018](#)).

1.3. The CAT and its international adaptation project

Here we present the adaptation to Catalan of the *Comprehensive Aphasia Test* (CAT), originally developed in English by [Swinburn, Porter, and Howard \(2005\)](#). The test evaluates the cognitive and linguistic abilities of people with aphasia, with a focus on language skills, and also includes a questionnaire to assess the patient's self-perception of the impact of aphasia on their life, the *Aphasia Impact Questionnaire* ([Swinburn et al., 2018](#)). It is being adapted to several languages by researchers from the Collaboration of Aphasia Trialists project, initially supported by the COST European Project (COST Action IS1208, 2014–2017) and subsequently by the Tavistock Trust for Aphasia (since 2017). As of now, the test has been adapted to Arabic ([Abou El-Ella et al., 2013](#)), Cantonese ([Pak-Hin Kong, 2024](#)), Croatian ([Kuvač Krajević, Matic, & Lice, 2020](#)), Danish ([Swinburn, Porter, Howard, Haaber Hansen, & Kaae Frederiksen, 2005](#)), Dutch ([Visch-Brink, Vandenborre, de Smet, & Mariën, 2014](#)), Hungarian ([Zakariás & Lukács, 2022](#)), Norwegian ([Jensen, Norvik, & Gram Simonsen, 2024](#)), Spanish ([Martínez-Ferreiro, Quique, Rodríguez, & Orellana, 2024](#)), Swedish ([Johansson et al., 2024](#)), and Turkish ([Maviş, Tunçer, Selvi-Balo, Tokaç, & Özdemir, 2021](#); [Özdemir, Maviş, & Tunçer, 2022](#)), and it is being adapted to several other languages, such as Basque ([Pourquié & Munarriz-Ibarrola, 2025](#)).

The goals of the collaborative group are to adapt a standardized assessment tool for the diagnosis of aphasia in different languages to, firstly, address the lack of tools in

languages other than English (e.g., [Ivanova & Hallowell, 2013](#)) and, secondly, to have an instrument to compare cross-linguistic data for both research purposes and the assessment of bilinguals with aphasia ([Fyndanis et al., 2017](#); [Martínez-Ferreiro, Arslan, et al., 2024](#)). For instance, [Panuccio et al. \(2025\)](#) carried out a systematic review of the tools used to assess aphasia and concluded that current tests are heterogeneous and often lack key indicators of quality. The authors argue that greater uniformity in assessment would allow for comparative cross-linguistic clinical studies and promote higher-quality research. This is particularly interesting for multilingual communities, such as those in which Catalan is spoken, as most speakers consider themselves bilingual.

The CAT was the selected test due to its interesting characteristics ([Fyndanis et al., 2017](#)). On the one hand, it is a brief and easy-to-administer comprehensive test ([Howard, Swinburn, & Porter, 2010a](#)), making it suitable for clinical practice, and was developed to assess cognitive and linguistic abilities for diagnostic purposes, as well as to monitor recovery during or after treatment ([Howard, Swinburn, & Porter, 2010b](#)). In addition, it evaluates across different language modalities (oral production and comprehension, as well as reading and writing). On the other hand, it controls for a wide range of psycholinguistic variables, such as frequency, imageability, and number of syllables, which are not controlled in other batteries ([Bruce & Edmundson, 2010](#)) and which facilitate the comparability of cross-linguistic adaptations. Moreover, even if the clinical diagnosis of aphasia is reliable, the use of an objective tool to exhaustively assess language can be very helpful in the clinical field, in order to establish the language profile of patients, to plan appropriate therapy, and to evaluate its outcome.

1.4. Aims of the study

The purpose of the present study is to present the Catalan adaptation of the *Comprehensive Aphasia Test* ([Swinburn, Porter, & Howard, 2023](#); [Swinburn, Porter, & Howard, 2005](#)), as well as the normative results of a group of Catalan speakers without language or speech disorders. To our knowledge, this is the first study of its kind. The normative data are fundamental for future comparative analysis to determine whether the adapted test is sensitive to the linguistic deficits associated with aphasia. It also allows us to review the battery and examine those subtests where greater intersubject variability is observed. This is crucial for establishing the range of non-pathological performance and cut-off scores, as well as determining whether the variability corresponds to socio-demographic variables or to language impairments in aphasia. Moreover, Catalan is an interesting language to examine, considering the sociocultural factors of the communities in which it is spoken. The paper is organized as follows: in section 2, we explain the process of adapting the CAT to Catalan, and describe its characteristics and main changes compared to the original test. In section 3, we present the methodology of the study we conducted to obtain normative data for the CAT–CAT; while in sections 4 and 5 we describe and discuss the results. Finally, in the last section, we draw the conclusions of our study and discuss future lines of research.

2. The CAT–CAT

The adaptation of the CAT to Catalan followed a series of structured phases: (1) initial selection and cultural adaptation of items, (2) psycholinguistic control and item validation, (3) pilot study to identify problematic items, (4) final adjustments and review, and (5) collection of normative data and standardization with people with aphasia. In this section, we first describe the changes made during the first four phases of adapting the CAT to Catalan, which followed the agreed-upon guidelines described in [Fyndanis et al. \(2017\)](#) and [Martínez-Ferreiro, Arslan, et al. \(2024\)](#). We also present the structure of the CAT–CAT and the changes made compared to the original. The complete list of subtests of the battery in Catalan is in Appendix A, and the materials are available in [Salmons, Rofes, and Gavarró \(2021\)](#).

2.1. Adaptation decisions

The first version of the adaptation contained items and visual materials that were selected for their cultural appropriateness and linguistic relevance, as explained in more detail in the following sections. Regarding cultural relevance, very minor changes were made, as the existing items (e.g., an image of a nun) in the cognitive screening subtests were already appropriate and recognisable in Catalan-speaking communities. Like in other language adaptations ([Martínez-Ferreiro, Arslan, et al., 2024](#)), in the linguistic subtests, we excluded items containing violent words or concepts such as *shoot* or *hit* in the sentence comprehension tasks, and adapted the proper names in the paragraph comprehension subtest. For example, *Sally*, *Richard* and *London* were replaced by *Anna*, *Joan* and *Barcelona*, respectively. Similarly, we substituted words like *miles* and *pounds* with *kilometres* and *euros*, which are more culturally appropriate.

In addition, we ensured that the items included in several subtests preserved key psycholinguistic properties such as imageability and frequency. Imageability refers to the ability to mentally represent a word or a concept. Previous studies (see references in [Rofes et al., 2018](#)) have claimed that in aphasia, words with high imageability (e.g., *pencil*) are easier or faster to retrieve than low-imageability words (e.g., *democracy*). [Rofes et al. \(2018\)](#) carried out a study to obtain imageability ratings for Catalan, given that no prior data were available. Another factor that has been shown to influence the performance of people with aphasia is frequency, which refers to how often words are used. Therefore, we controlled for this variable classifying as high-frequency items those words with a relative frequency greater than 40 per million, and as low-frequency items those with a relative frequency of less than 12 per million. The data concerning frequency were obtained from NIM software ([Guasch, Boada, Ferré, & Sánchez-Casas, 2013](#)).

Furthermore, a name agreement task was carried out to select the pictures included in certain tasks, namely, the word recognition and naming subtests in both spoken and written modalities. A total of fifty-two Catalan speakers were asked to name 135 pictures. Only those items that reached at least 90% agreement in naming were included in the study as target

items, while the remaining items were discarded. For example, Fig. 1 shows a discarded image, given that only 75.5% of the participants named it with the target word *cuc* ‘worm’ (or the variant *cuc de terra* ‘earth worm’). The other participants used synonyms –such as *llambric*–, semantically related words –such as *llimac* ‘slug’, *serp* ‘snake’ or *ham* ‘hook’–, Spanish words –*gusano* ‘worm’– or literal translations from Spanish, such as the incorrect word *llombriu* (from *lombriz*, ‘worm’ in Spanish). We then conducted a pilot study with twenty Catalan-speaking participants without cognitive disorders (18–65 years old; 10 women; education level: 12 higher, 6 intermediate, and 2 basic; 13 speakers of Eastern Catalan and 7 of Western Catalan) to identify problematic items. The preliminary version of the CAT–CAT used in the pilot study included additional items to have alternatives after deleting the problematic ones. After the pilot study, the test was reviewed and several adjustments described in the following sections were made to improve the battery. Some of these changes entailed modifications with respect to the original test (see section 2.2.1), though the basic structure remained unchanged for comparability purposes. Finally, we checked that the psycholinguistic and linguistic variables of the final version were consistent with what has been explained above. The last phase of the adaptation process consists of collecting the normative data, which we present in section 4, and the standardisation with people with aphasia, which is still ongoing (see some preliminary results in Salmons, Muntané-Sánchez, & Gavarró, 2022, 2024).

2.2. The structure of the CAT–CAT

The CAT–CAT maintains the structure of the original test, which includes a brief cognitive screen and a language battery (see Appendix A). The main difference between the Catalan version and the original test in English is that the former does not include the *Aphasia Impact Questionnaire* (AIQ; Swinburn et al., 2018). However, a version in Catalan of the AIQ-21 can be found at <https://www.aiq-21.net/>.

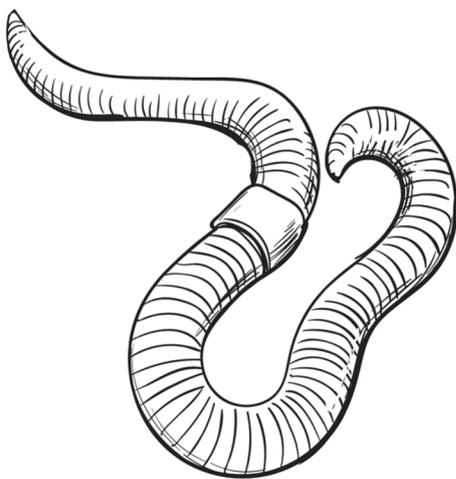


Fig. 1 – Example of a discarded image (for the word *cuc* ‘worm’).

2.2.1. The cognitive screen

The first part of the test contains six subtests that primarily evaluate cognitive deficits not specific to language, such as anopsia, semantic and visual memory impairments, apraxia or dyscalculia. It also includes a verbal fluency task with semantic and phonological categories to assess naming abilities along with executive function and attention skills. The goal of these tasks is to detect cognitive deficits that can influence the results of the linguistic tasks, even though they are not meant to substitute specific diagnostic tools for the mentioned cognitive impairments.

The Catalan adaptation maintains the structure and the number of items of all the subtests with minor modifications. The first change concerns the semantic memory task (subtest 2): the item that was problematic in the pilot study –where 8 out of 20 participants made an error, as they associated the picture of a mask with a ballerina instead of a clown– was converted into the practice item, and the original practice item was moved into the main task. As a consequence, we also reordered the items in the recognition memory task (subtest 4), since the images that need to be recalled are the ones that appear in the semantic memory subtest. In addition, we also replaced a picture of a cradle that was not meant to be the target item (a wristwatch) in the recognition memory task, because it led to a high number of errors. On the other hand, the phonological criterion in subtest 3 (verbal fluency) was changed for clarity: the sound [s] was substituted with [p], as the former can be orthographically represented by more than one letter in Catalan. Finally, we also modified one item in subtest 5 (gesture-object use): we included a picture of a ladle instead of scissors, since 8 of the participants in the pilot study used a part of their body as the object itself (which is penalized).

2.2.2. The language battery

The second part of the test includes twenty-one tasks to assess the following linguistic processes: comprehension, production, repetition, naming, reading, and writing. The comprehension part contains five subtests that evaluate the comprehension of oral and written words and sentences, as well as the oral comprehension of short stories. The repetition subtests include two tasks that assess verbal working memory, in particular, the digit and word spans, along with three repetition subtests involving different types of words and pseudowords. Similarly, four tasks assess the reading skills of simple, complex and function words, and pseudowords. The two naming tasks, on the other hand, evaluate the oral production of nouns and actions. With regard to the writing part, it consists of three subtests that examine copying skills, object naming, and writing to dictation. Finally, the test also includes a picture description task that participants describe orally and in written form.

All the linguistic properties controlled for in the subtests from this part were revised based on the characteristics of Catalan. One of these variables is word length. In the CAT–CAT, we included monosyllabic and disyllabic words as short words, and trisyllabic and tetrasyllabic words as long words: for example, *dit* ‘finger’ (1 syllable) and *papallona* ‘butterfly’ (4 syllables) in the naming test. Using only 1- and 3-

syllable or 2- and 4-syllable words in Catalan was not feasible, as this restriction made it impossible to satisfy the psycholinguistic criteria (e.g., imageability) and to achieve sufficient name agreement. For this reason, we opted for a broader distribution (1–2 vs 3–4 syllables) in order to preserve the required 2-syllable difference between categories. Additionally, animacy was also considered when selecting low-frequency nouns in naming tasks: half of the items were animate items and the other half, inanimate. Regarding subtest 18 (action naming), the five verbs elicited were two-syllable words. In tasks that include complex words, such as the repetition or reading subtests, four-syllable words with suffixes and prefixes were selected (e.g., *impuresa* ‘impurity’).

In the word recognition tasks (subtests 7 and 8), the number of distinctive phonological features was also controlled. For example, target words differed from phonological distractors by one or two phonological features of one sound (e.g., *canya* [ˈkaɲə] ‘(fishing) rod’ and *cama* [ˈkama] ‘leg’), which could be a consonant, as in the former example, or a vowel (e.g., *llet* [ˈlet] ‘milk’ and *llit* [ˈlit] ‘bed’), and appear in different syllable positions (e.g., *riu* [ˈriw] ‘river’ and *niu* [ˈniw] ‘nest’; *llac* [ˈlak] ‘lake’ and *llaç* [ˈʎas] ‘ribbon’). Word recognition subtests also include a semantic distractor, which belongs to the same semantic category as the target word, and an unrelated distractor, which is semantically related to the phonological distractor. For example, for the target word *dia* ‘day’, the phonological distractor was *via* ‘railway’, the semantic distractor *nit* ‘night’ and the unrelated distractor, *tren* ‘train’.

Sentence length, on the other hand, was particularly relevant in the sentence repetition task that assesses the word span working memory (subtest 16). In order to preserve the comparability with other languages, we maintained the number of function and content words in all items. Sentence complexity was also controlled for in this task and in subtests 9 and 10 (sentence comprehension). We included the same structures as in the original, though with minimal changes in order to make them feasible in Catalan. For example, the use of the simple present tense was preferred over the present continuous because it is more appropriate for that context. In contrast, we maintained passive sentences for comparable purposes, despite the fact that they are not very frequent in Catalan. Moreover, we included two items with direct object clitic left dislocations (Fig. 2), which are very productive in

Catalan, present a noncanonical word order, and have been shown to be difficult for individuals with aphasia (Salmons & Gavarró, 2022). As a result, the two sentence comprehension subtests have two extra items in the Catalan version. However, these items can be omitted or, if preferred, used to replace the passive sentences if the goal is to compare the results with another language. Some items, despite preserving the original structure, were modified to make them clearer and avoid the errors observed in the pilot study, and the visual stimuli were changed accordingly as exemplified in Fig. 2. Thus, sentence comprehension tasks included: sentences with verbs that require one and two arguments (e.g., *plorar* ‘to cry’ and *pintar* ‘to paint’, respectively), sentences with locatives (e.g., *El got és sota el plat*. ‘The glass is under the plate.’), embedded clauses (*La catifa on hi ha la gata és grisa*. ‘The rug where the cat is on is grey.’), and semantically reversible actives and passives with different word orders (Fig. 2). The adaptation procedure of these tasks, including the introduction of dislocations, is discussed in more detail in Martínez-Ferreiro, Arslan, et al. (2024).

Catalan has a more transparent orthography than English, but less than Spanish. For example, the word *doctor* is pronounced as [dukˈto] in Central Catalan (cf. the southwestern pronunciation [dokˈtor]). However, the phonological processes underlying these differences can only significantly interfere with writing, rather than reading. For this reason, this variable was only taken into account in the written subtests, in which we used monosyllables when possible to avoid certain phonological processes, such as vowel reduction or final obstruent devoicing, except when it was not possible. In subtest 26 (writing to dictation), for example, two orthographic transcriptions are accepted as correct answers for the meaningless pseudoword *plurc* (or *plurg*). In all the writing subtests, the number of letters was taken into account, along with the above-mentioned frequency, imageability, and morphological complexity.

The subtests that assess the oral and written production abilities, namely, the image description tasks (subtests 19 and 27) have been adapted in line with other language adaptations (Martínez-Ferreiro, Arslan, et al., 2024). In fact, the scoring system in the CAT–CAT adopts the Likert-scale system used in the Dutch and Norwegian versions (Jensen et al., 2024; Visch-Brink et al., 2014), though with slight modifications.

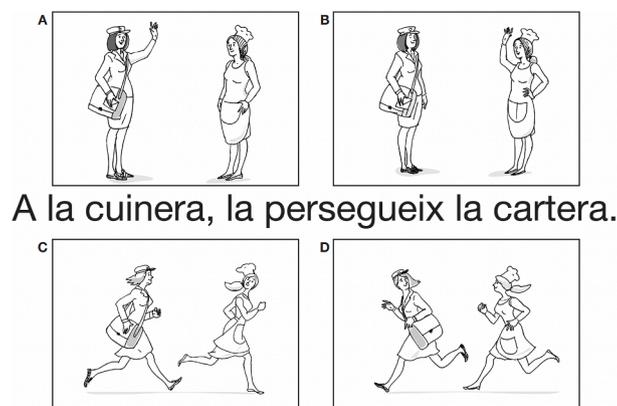


Fig. 2 – Images presented in subtest 10 for the item ‘The cook, the mailwoman is chasing her’.

The goal of these changes is to make these subtests easier to score and more reliable regardless of the type of aphasia, since the scoring in the original version included a count of the total number of words produced. In the CAT–CAT, the scoring system takes into account three variables for form that are rated in a scale from 0 to 3: fluency (only in the oral description), grammatical complexity and grammaticality. These three factors were already considered in the original test and are maintained in other languages. The main difference lies in the factors evaluated as content. In the CAT–CAT, there are three content variables: the number of relevant content units (0–6), nouns (0–8), and actions (0–5) produced. A more detailed explanation of the scoring system is found in [Table A2](#) in Appendix A.

2.3. Linguistic variation

During the adaptation, the Catalan dialects spoken in Spain and Andorra were taken into account, which are the ones that the individuals who participated in the present study speak. Despite that Catalan dialects can differ at various linguistic levels, Catalan-speakers from these regions are familiar with the oral standard register of Catalan based on the norms set by [Institut d'Estudis Catalans \(2018\)](#). Therefore, most of the differences among varieties are expected in the production subtests, where dialectal varieties should always be accepted. For instance, the use of the word *xic* or *xiquet* by speakers of certain Western varieties is acceptable to describe the image meant to elicit the word *nen* 'boy' in the naming subtest, as well as the eastern Balearic varieties *nin* or *al·lot*. Similarly, variation related to aspects other than regional dialects was also considered. With respect to the verb form elicited in the action naming task (subtest 18), Catalan allows for different options that should be accepted as correct responses. For example, in [Fig. 3](#), an acceptable response to the questions *Què fa?* 'What is she doing?' includes the infinitive form (e.g., *saltar* 'jump') and the third person form in different aspects (e.g., *Salta.* or *Està saltant.* 'She is jumping.').

3. Method

3.1. Participants

A total of 110 subjects with a mean age of 50.15 years ($SD = 19.11$) and different educational backgrounds participated in the study ([Table 1](#)). All the participants reported that Catalan was their dominant language, though all of them stated that they were also bilingual speakers of Spanish. The level of bilingualism or competence in Spanish was not assessed, as the goal of the study was not to test them in their second or third languages. Most participants (75/110) were speakers of Central Catalan, which is one of the dialects of Eastern Catalan, while the rest were mostly speakers of Northwestern Catalan. Except for three participants, all the others were right-handed. Participants who had completed primary education were classified as having basic education (fewer than 12 years); those with a high school education degree or a higher vocational diploma were classified as having intermediate education; and those who had an academic



Fig. 3 – Materials presented in the action naming task for the practice item 'to jump'.

bachelor's degree were classified as having higher education. The participants reported that they did not have any psychological, language or learning disorders or any other disabilities prior to the administration of the task that could influence the results.

3.2. Materials

All the participants were administered the Catalan version of the *Comprehensive Aphasia Test* ([Salmons et al., 2021; Swinburn, Porter, & Howard, 2005](#)), described in section 2.2. In most subtests, the number of correct responses was taken into account. Some tasks (e.g., oral naming and repetition tasks), however, were scored using two different scales, following the original. The 0–1 scale takes into account whether the response is correct, in which case it scores 1, or incorrect, which scores 0. On the other hand, the scores based on the 0–2 scale consider other factors, such as whether the response is correct and without delay (2 points), or correct

Table 1 – Characteristics of participants ($n = 110$).

Age (years)	
18-29	22 (20.0%)
30-39	13 (11.8%)
40-49	16 (14.5%)
50-59	22 (20.0%)
60-69	20 (18.2%)
70-79	9 (8.2%)
+80	8 (7.3%)
Education	
Basic	29 (26.4%)
Intermediate	43 (39.1%)
Higher	38 (34.5%)
Sex	
Female	65 (59.1%)
Male	45 (40.9%)
Dialect	
Western	33 (30.0%)
Eastern	77 (70.0%)

after a 5-s delay, a repetition of the item on request or after self-correction (1 point), or incorrect (0 points). The only exceptions are digit and word span subtests, in which the scores in the 0–2 column of Table 5 are doubled, that is, the number of digits or words correctly repeated is multiplied by two. In contrast, in writing tasks, the scoring takes into account the number of letters correctly spelled, rather than the accuracy rate. Every letter correctly spelled scored one point, omissions and misspellings scored zero, and additional letters were penalized (–1).

3.3. Procedure

The procedure of the study was approved by the Ethics Committee of the Universitat Autònoma de Barcelona (CEEAH 5656) and followed the Declaration of Helsinki ethical standards. All the subjects provided their written informed consent prior to participation. The tests were administered in quiet rooms without distractions in various locations, mostly at the participants' homes. Prior to the task, the administrator interviewed the participants to collect the relevant personal data and to explain the project. All the subtests include practice items in order to make sure that the participant understands the task. The responses were collected manually, except for the oral descriptions, which were recorded and later transcribed. The administration of the test took between twenty and forty minutes to complete. The tasks were administered by trained examiners, including native speakers of both Western and Eastern Catalan, who read aloud the items. No items were prerecorded. Examples of participants with and without aphasia performing some of the subtests of the CAT–CAT can be listened to at <https://filcat.uab.cat/einaling-corporus-cat-cat/>.

3.4. Statistical analysis

The statistical analysis was performed using R software (RStudio Team, 2024). The descriptive statistics calculated for each subtest were the mean, the standard deviation, and the range. In addition, cut-off values were calculated, which represent scores that were exceeded by 95% of participants. These values were calculated following the same method used in the original test (Swinburn, Porter, & Howard, 2005). The Shapiro–Wilk test was used to assess the distribution of data.

For those subtests where the standard deviation was not zero, the possible associations between different measures and age were analysed by calculating the Kendall's Tau correlation coefficient, due to the non-normal distribution of the variable of age and the presence of ties in many subtests. With regard to education, considering that it is an ordinal variable, we applied the Kruskal–Wallis test to see whether there were any statistically significant differences among the three educational groups across the various subtests and scoring scales. If significant or near-significant differences were observed, we performed multiple pairwise comparisons between the three educational groups through Dunn's test. *p*-values were adjusted using the Bonferroni correction for multiple comparisons across 43 subtests. In order to compare the results of the two description subtests, the Wilcoxon

signed-rank test was used after normalizing the data when necessary, because of the non-normal distribution of the data. The statistical level accepted as significant in all tests was 1%, both for consistency and because of the variability in the sample. The dataset for this study can be found at <https://doi.org/10.34810/data2416>.

4. Results

In this section, we report the descriptive and inferential results for the CAT–CAT, including the scores across subtests and the influence of variables, such as age and educational level. All the *p*-values reported were adjusted using the Bonferroni correction for multiple comparisons (see section 3.4).

4.1. The cognitive screen

The results in the six subtests from the cognitive screen (Table 2) showed that the participants performed very well on average across all subtests, but particularly in the semantic memory, recognition memory, and gesture object use, where the resulting cut-off scores are higher. In general, there was little variability across subjects in this part, except in the word fluency tasks, with coefficients of variation (CV) of 29.3% and 50.5% for the semantic and phonological categories, respectively. For instance, the scores on the semantic category variable were significantly correlated to age according to Kendall's Tau ($\tau = -.3$, $p < .001$; Fig. 4). Although the difference among the three educational groups was not significant (Kruskal–Wallis test: $\chi^2 = 2.79$, $p = .018$), the group with basic education named fewer animals per minute than the other two groups (Fig. 4). In fact, a deeper statistical analysis revealed that the difference in performance between the groups with basic and higher education was significant (Dunn's test: $Z = -3.96$, $p < .001$). The errors made in the verbal fluency tasks were very few relative to the total number of responses: 3.63% (86 total errors) in the semantic category and 6.38% (33 total errors) in the phonological category. The most frequent errors involved words in Spanish (29 in the semantic category and 26 in the phonological category) and repetitions (33 and 3, respectively). Less frequent errors included changes of category (17 in the semantic category and 2 in the phonological category; e.g., *farm* in the semantic category) or other types of errors (7 in the semantic category and 2 in the phonological category), such as proper names (e.g., *Nemo*).

4.2. The comprehension subtests

The participants performed at ceiling on all the comprehension subtests (Table 3). The scores based on the 0–2 scale tended to exhibit a slightly greater intersubject variability than those based on the 0–1 scale (see section 3.2): for example, the coefficients of variation were 3.86% and 5.14% for the scores based on the 0–1 and 0–2 scales, respectively, in the spoken sentences comprehension task. Moreover, the scores on the 0–2 scale for the subtest that evaluated the comprehension of spoken words were the only results significantly associated with age ($\tau = -.37$, $p < .001$), and also

Table 2 – Results on the cognitive screen of the CAT-CAT.

Cognitive subtests	Maximum	Mean	SD	Range	Cut-off
Line bisection	±6	-.18	1.14	-6 - 2	±2.5
Semantic memory	10	9.82	.51	7-10	9
Word fluency					
animals	Unlimited	20.74	6.08	7-39	10
p-	Unlimited	4.40	2.22	1-12	1
Recognition memory	10	9.70	1.05	2-10	9
Gesture object use	12	12.00	.00	12-12	12
Arithmetic	6	5.66	.62	3-6	4

the only ones in which a significant difference was observed across educational groups ($\chi^2 = 21.80, p = .001$). Yet, the number of errors made by the participants in the word recognition tasks was very low: 10 in the spoken word comprehension subtest (.61% of total responses), and 9 in the written word comprehension subtest (.55% of total responses). In the former task, the item with more errors (5) was the word *canell* ‘wrist’, which was confused with *camell* ‘camel’ in all cases; whereas in the latter, the item with more errors (4) was *roca* ‘rock’ as three participants pointed to the image with a mountain instead of the target picture. In the written word recognition task, all errors involved pointing to the semantic distractor, except for one instance in the written word subtest, in which a participant pointed to the phonological distractor.

In the spoken word comprehension subtest, 6 errors involved pointing to the phonological distractor, whereas the other four involved the selection of the semantic distractor. With regard to the spoken and written sentence comprehension tasks, the participants made a total of 45 and 31 errors, respectively. Most of these mistakes involved misinterpretations of active reversible sentences with locatives, such as *El gota sota el plat és blau*. ‘The glass under the plate is blue.’ (39 and 20 errors, respectively). Mistakes with reversible noncanonical sentences, such as passives or dislocations, only accounted for 4 and 9 errors in spoken and written subtests, respectively.

4.3. The naming subtests

The results on the naming subtests were also at ceiling (Table 4), and only the score in the noun naming task based on the

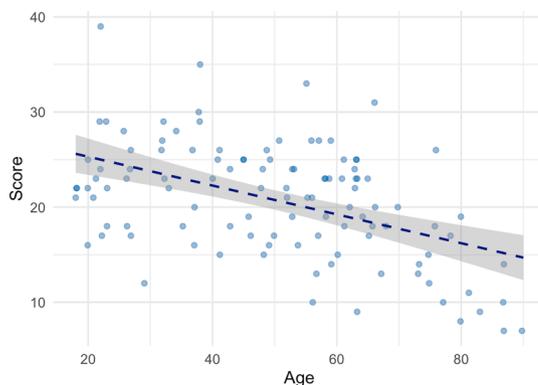


Table 3 – Results on the comprehension tasks of the CAT-CAT.

Comprehension subtests	Max	Mean	SD	Range	Cut-off
Spoken words					
0-1 scale	15	14.91	.32	13-15	14.00
0-2 scale	30	29.55	.87	26-30	28.00
Written words					
0-1 scale	15	14.91	.32	13-15	14.00
0-2 scale	30	29.70	.71	26-30	28.00
Spoken sentences					
0-1 scale	18	17.59	.68	14-18	16.00
0-2 scale	36	34.45	1.77	24-36	32.00
Written sentences					
0-1 scale	18	17.71	.64	15-18	16.00
0-2 scale	36	35.05	1.55	28-36	32.00
Paragraphs	4	3.93	.26	3-4	3.00

0-1 scale was significantly associated with age ($r = -.32, p = .002$), despite that the coefficient of variation in this task was very low (1.6%). The participants made only fourteen mistakes in the noun naming subtest, which correspond to the .53% of the total responses, and one in the verb naming task, which is equivalent to the .19% of the total responses. The highest number of errors in naming nouns involved the items *foca* ‘seal’ (4 errors), *granota* ‘frog’ (3) and *esquimal* ‘inuit’ (3), *papallona* ‘butterfly’ (2), *zebra* (1), *hospital* (1); all of which are low-frequency words. In most cases, they did not reply; however, in five instances, the participants replied correctly in Spanish, more specifically, the Spanish words *rana* ‘frog’ and *mariposa* ‘butterfly’, for *granota* and *papallona*, respectively. The other responses involved semantically-related words, such as *girafa* ‘giraffe’ and *senyor* ‘sir’, instead of *zebra* and *esquimal* ‘Inuit’. On the other hand, the only mistake in the action naming task involved a semantically close verb: one participant described the image in Fig. 3 as *fer gimnàsia* ‘to work out’ (colloquial form) instead of *saltar* ‘to jump’. No significant differences were found among the groups based on education level in these two tasks.

4.4. The repetition subtests

The results on the repetition subtests of simple and complex words were at ceiling (Table 5), whereas the scores in the

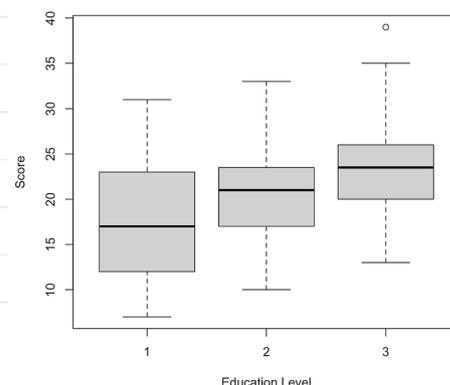


Fig. 4 – Performance on the verbal fluency task (animals) by age and education level (1: basic, 2: intermediate, 3: higher).

Table 4 – Results on the naming tasks of the CAT–CAT.

Naming subtests	Max	Mean	SD	Range	Cut-off
Nouns					
0–1 scale	24	23.86	.39	22–24	23.00
0–2 scale	48	47.53	.91	44–48	46.00
Verbs					
0–1 scale	5	4.99	.09	4–5	5.00
0–2 scale	10	9.97	.21	8–10	10.00

pseudoword repetition task were slightly lower. For instance, the results based on the 0–2 scale on the pseudoword subtest were significantly correlated with age ($\tau = -.27, p < .001$). The participants made a total of 7 errors in repeating pseudowords, producing phonetically similar words to the target and always preserving the vowels; for example, two participants said ['kuts] instead of the target ['guts]. The participants' results were also at ceiling on the word span subtest, which assesses the ability to repeat sentences. Regarding the working memory subtest that evaluated the digit span, intersubject variability (CV = 17.8%) was observed associated with age ($\tau = -.36, p < .001$ for both scores). Although there were no significant differences among groups by educational level ($\chi^2 = 8.65, p = .76$) in this subtest, the group with a basic level of education performed slightly worse on average than the other groups. Like in other subtests, the variability was greater when considering the scores based on the 0–2 scale.

4.5. The reading and writing subtests

The results on the reading tasks were at ceiling and showed very little intersubject variability (Table 6). No significant correlations between the results on these subtests and age were observed. Likewise, no significant differences were observed across groups with different educational levels. On the other hand, in the subtests that assess writing (Table 7), the scores of the participants were lower in comparison with the oral parts of the CAT, and showed greater variability across subjects. In the copying subtests, one participant scored very low (5/27) because she did not follow the

Table 5 – Results on the repetition tasks of the CAT–CAT.

Repetition subtests	Max	Mean	SD	Range	Cut-off
Simple words					
0–1 scale	16	15.97	.21	14–16	16.00
0–2 scale	32	31.87	.59	27–32	31.00
Complex words					
0–1 scale	3	3.00	.00	3–3	3.00
0–2 scale	6	5.98	.13	5–6	6.00
Pseudowords					
0–1 scale	3	2.94	.25	2–3	2.00
0–2 scale	6	5.67	.65	3–6	4.00
Digit span					
0–1 scale	7	6.06	1.08	3–7	4.00
0–2 scale	14	12.13	2.16	6–14	8.00
Word span					
0–1 scale	6	5.99	.09	5–6	6.00
0–2 scale	12	11.98	.19	10–12	12.00

instructions to copy the words in capital letters. Similarly, another participant did not write some of the items in capital letters and scored only 22. The rest of the participants scored higher, between 26 and 27. The participants experienced greater difficulties in the naming and copying-to-dictation subtests. Most misspellings consisted of phonetic errors: for example, several participants wrote *ídul* instead of the normative form *ídol* reflecting the Eastern pronunciation of the word ([i'dul]). With regard to accuracy rates in the written naming subtest, the participants made seven errors regarding the production of the target word in the writing object naming subtest, which correspond to 1.27% of total responses, and four of them involved nouns in Spanish. The scores on the naming and dictation tasks were significantly correlated with age ($\tau = -.34, p < .001$ and $\tau = -.31, p = .001$, respectively). Like in previous subtests, no significant differences were observed across the three educational groups.

4.6. The picture description subtests

The overall results on the spoken and written description subtests (Tables 8 and 9) varied across subjects, but a quick comparison relative to the maximum possible score shows slightly higher performance on the spoken task (88.39% vs 81.76% correct), which also showed less intersubject variability. The Wilcoxon signed-rank test confirmed that their performance on the oral description subtest was significantly higher than their performance on the written description subtest ($V = 4048, Z = 2.97, p < .001$). In addition, the overall score on the written description subtest, but not the spoken description, significantly correlated with age ($\tau = -.35, p < .001$). In both modalities, the group with higher education performed slightly better (Fig. 5); however, the difference among the three groups was not significant (oral: $\chi^2 = 6.55, p = 1.00$; written: $\chi^2 = 11.76, p = .16$). Pairwise comparisons between groups revealed that the group with basic education performed significantly worse than the group with higher education only in the written description ($Z = -3.37, p = .002$). It is important to note that one participant scored zero on the written task because she refused to write in Catalan and responded in Spanish.

The scoring of these subtests took into account both content and form variables, as described in section 2.2. The

Table 6 – Results on the reading tasks of the CAT–CAT.

Reading subtests	Max	Mean	SD	Range	Cut-off
Simple words					
0–1 scale	24	23.99	.09	23–24	24.00
0–2 scale	48	47.93	.32	46–48	47.45
Complex words					
0–1 scale	3	3.00	.00	3–3	3.00
0–2 scale	6	5.98	.13	5–6	6.00
Function words					
0–1 scale	3	3.00	.00	3–3	3.00
0–2 scale	6	6.00	.00	6–6	6.00
Pseudowords					
0–1 scale	3	2.98	.13	2–3	3.00
0–2 scale	6	5.93	.32	4–6	5.45

Table 7 – Results on the writing tasks of the CAT–CAT.

Writing subtests	Max	Mean	SD	Range	Cut-off
Copying	27	26.64	2.26	5–27	26.45
Naming	20	19.35	1.81	9–20	16.00
Dictation	28	27.42	1.20	20–28	25.40

Table 8 – Results on the oral picture description task of the CAT–CAT.

Oral description	Max	Mean	SD	Range	Cut-off
<i>Content</i>					
Nouns	8	6.85	.95	5–8	5.00
Verbs	5	4.21	.83	2–5	2.45
Events	6	4.70	1.02	2–6	3.00
Total	19	15.76	2.33	9–19	11.00
<i>Form</i>					
Fluency	3	3.00	.00	3–3	3.00
Grammaticality	3	2.99	.09	2–3	3.00
Grammatical complexity	3	3.00	.00	3–3	3.00
Total	9	8.99	.09	8–9	9.00
Total score	28	24.75	2.35	18–28	20.00

Table 9 – Results on the written picture description task of the CAT–CAT.

Written description	Max	Mean	SD	Range	Cut-off
<i>Content</i>					
Nouns	8	6.49	1.46	0–8	4.00
Verbs	5	4.02	.99	0–5	2.45
Events	6	4.14	1.46	0–6	2.00
Total	19	14.65	3.44	0–19	9.00
<i>Form</i>					
Grammaticality	3	2.91	.37	0–3	2.00
Grammatical complexity	3	2.88	.42	0–3	2.00
Total	6	5.79	.73	0–6	5.00
Total score	25	20.44	3.84	0–25	14.00

largest difference between the two tasks was observed in the form score, which was significantly higher in the oral modality ($V = 105$, $Z = 8.75$, $p < .001$). The content scores also differed between tasks, though to a lesser extent ($V = 2731$, $p = .005$). Variability differed across subtests: content variables showed greater intersubject variability in both modalities ($CV = 23.5\%$ for the written subtest and $CV = 14.8\%$ for the oral subtest). In contrast, the form variable showed greater variability in the written subtest ($CV = 12.61\%$) compared to the oral description ($CV = 1\%$). Moreover, the results on the written subtest significantly correlated with age, both on form and content scores ($r = -.34$, $p < .001$ and $r = -.31$, $p < .001$, respectively), with scoring decreasing as age increased (Fig. 6). In fact, an analysis of the distribution of the scores on the written description subtest across age groups shows that the groups with participants older than 60 have lower medians than younger groups (Fig. 7).

Language-mixing behavior was observed in these two subtests. For example, more than one participant wrote the word *silló*, which is an adaptation of the Spanish word *sillón*

‘armchair’ (*butaca* in Catalan), and others wrote the verb *enterarse*, which means ‘to become aware of’ (*adonar-se* in Catalan). Similarly, some participants used the word *peluche* ‘stuffed animal’ or *mando* ‘remote’ (*animal de peluix* and *comandament* in Catalan, respectively) in their oral descriptions. Such occasional and isolated interference was not penalized.

5. Discussion

The main goals of the present study were to present the adaptation of the CAT (Swinburn, Porter, & Howard, 2005) into Catalan and to provide normative data. Tools to specifically assess and diagnose aphasia in Catalan-speaking individuals are scarce, and they lack normative data. However, previous studies have shown that it is important to evaluate individuals in their first language in order to achieve reliable diagnoses (Kuzmina et al., 2019). Similarly, the relevance of developing language assessment tools taking into account language-specific properties and sociocultural aspects, and avoiding direct or informal translation of existing tests, has also been claimed in the literature (among others, Lluent Vallet et al., 2002; Minh Nguyen et al., 2024). The adaptation of the CAT into Catalan took into account all these variables, as well as psycholinguistic factors, such as frequency or imageability. Therefore, the present study represents the first step toward the CAT–CAT becoming the first standardized tool for the assessment and diagnosis of language disorders in Catalan-speaking individuals with aphasia.

5.1. Normative data

The overall performance of the participants was very high across tasks, reaching ceiling-level performance in most subtests. These findings show that the Catalan adaptation of the CAT meets the criteria to be used as a reliable diagnostic tool, as the potentially problematic items that could lead to false positives were removed during the earlier phases of the adaptation process (see Fig. 1 in section 2). This is further supported by the low interference rates from the second language, discussed later, for example, in naming and verbal fluency tasks. The number of responses in Spanish was considerably lower in the former (.19% vs 46.22% of total errors, respectively), which reflects the careful selection of items. Hence, the results reported in the present study establish the range of normative performance and the cut-off scores for the CAT–CAT, which are crucial to distinguishing pathological from non-pathological verbal behavior.

5.2. Intersubject variability

Despite the fact that the participants performed at ceiling on most subtests, variability across subjects was observed in certain tasks. More specifically, moderate-to-high variability was observed in word fluency measures ($CV = 23.5\text{--}50.5\%$), and in the content score of the written description subtest; while other subtests showed moderate-to-low variability, such as the digit span subtest or the content form score for the written description subtest ($CV = 14.8\text{--}17.8\%$). Our

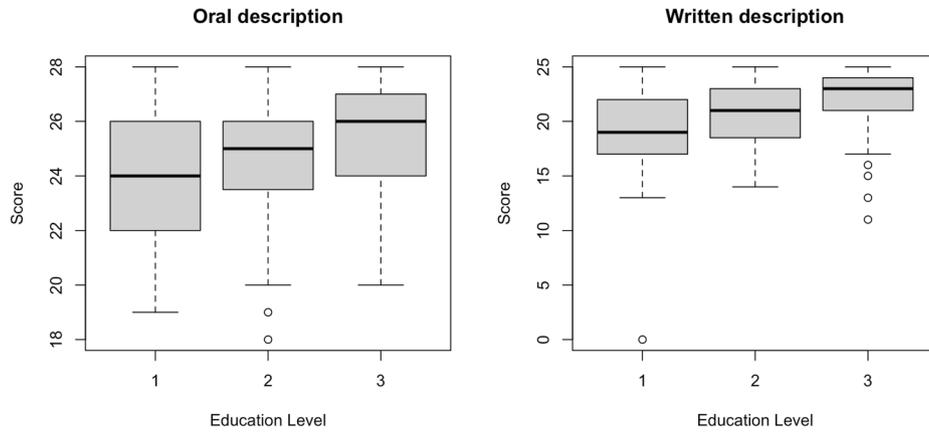


Fig. 5 – Performance on the description tasks by education level (1: basic, 2: intermediate, 3: higher).

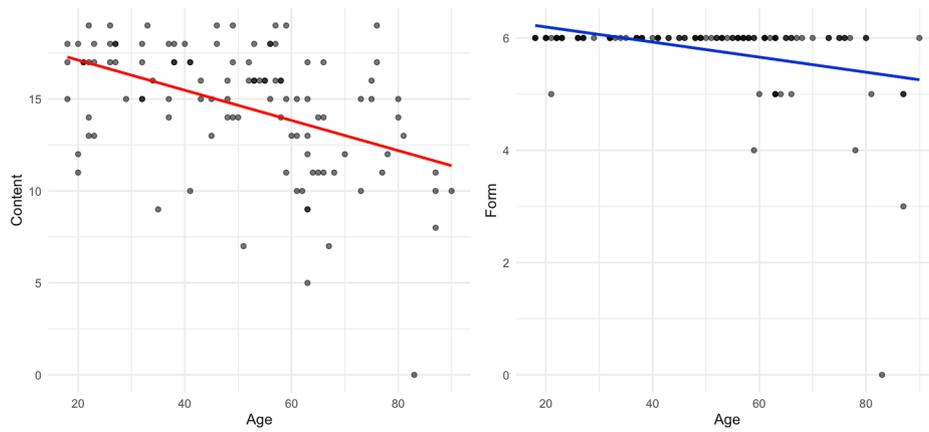


Fig. 6 – Correlation of age with written description task variables.

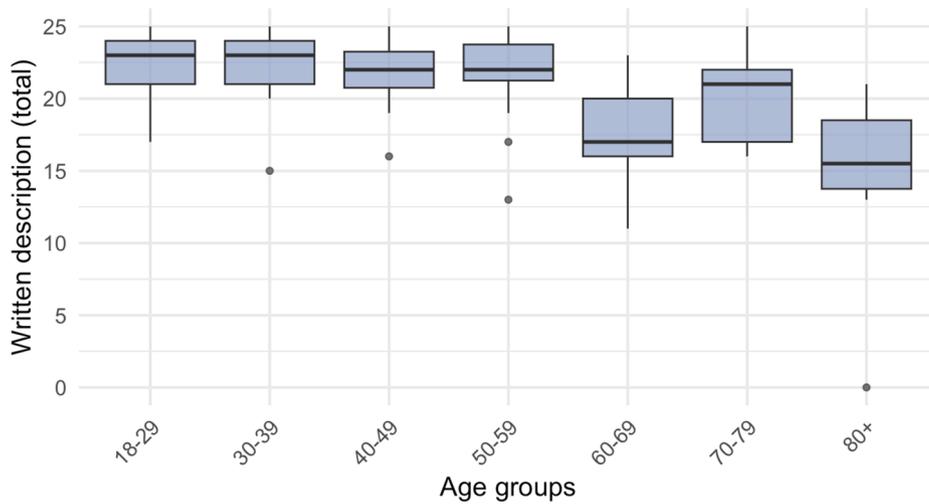


Fig. 7 – Distribution of written description scores by age group (median and interquartile range).

findings revealed that the scores on all these subtests were significantly associated with age, whereas significant differences among educational groups were only observed in the word fluency task, more specifically, between the groups with basic and higher education. Whenever an association between age and scores was found, it indicated that the performance worsened with increasing age. This suggests that some of the linguistic cognitive functions assessed change over time, and some –such as word fluency– decay, which is consistent with what has been reported in the literature (see Wang & Wang, 2024, and the references cited therein). These findings also highlight the relevance of having included a meaningful proportion of people over 50 (53.7%) in the normative sample, which ensures the validity of the reported cut-off values.

Our findings also revealed that the scores based on the 0–2 scale tended to have a greater coefficient of variation than those based on the 0–1 scale. As previously mentioned (section 3.2), the score based on the 0–2 scale takes into account and penalizes delayed responses, repetition requests and self-corrections. Our findings suggest that this is a more sensitive measure that could more easily detect intersubject variability, especially variability related to ageing or education level. For example, in the spoken word comprehension subtest (Table 3), the accuracy of all participants was very high (13–15/15), showed very little variability, and neither correlated with age nor differed among educational groups. Yet, their results on the 0–2 scale did correlate with age and differed among educational levels. Hence, the inclusion of this scoring system provides additional relevant information related to socio-demographic factors and other variables. For instance, in a preliminary study with Catalan-speaking people with aphasia (Salmons et al., 2022), the scores based on the 0–2 scale –but not on the 0–1 scale– on the oral sentence comprehension task correlated with performance on the digit span subtest, a measure of working memory, suggesting that the 0–2 scale may be more sensitive to the impact of processing deficits on language abilities, even when the overall performance is high or impairments are milder.

Hence, analyzing the variability among control subjects is of particular interest, especially considering that this is the first study of its kind with Catalan-speaking individuals, as it provides insight into the sociodemographic factors that influence language abilities. Most subtests, including naming, word repetition, and reading, showed low variability across subjects, indicating that the items in the Catalan adaptation of the CAT are reliable for detecting language impairments. The only exception was the verbal fluency tasks, which displayed high intersubject variability; these findings suggest that picture naming is more suitable for assessing potential lexical retrieval deficits.

5.3. Dialectal variation

The high performance across subtests suggests that the Catalan adaptation of the CAT is suitable for the different dialects tested. As already stated in section 1, the adaptation of the test took into account Eastern and Western varieties of Catalan spoken in Spain and Andorra, whose speakers are familiarized with the Central and standard varieties. Hence,

like other language versions of the CAT (see Martínez-Ferreiro, Arslan, et al., 2024 for the case of Spanish), the dialectal variability observed was found mostly in production subtests, as shown by the little variability observed among subjects in reading and comprehension tasks. And yet, it was minimal and did not interfere with the outcome of the assessment. For example, in the object naming task, two participants used the form *beliana* instead of the standard word *papallona* to describe the image of a butterfly. These infrequent cases did not pose a problem, given that administrators are instructed to accept such responses. However, other varieties of Catalan are spoken in the Roussillon region of France and in Alghero, Italy. Catalan-speaking individuals in these regions, besides speaking different dialects from the ones tested in the present study, are not usually taught Catalan in schools and have much more limited access to Catalan-speaking communities, services, or cultural products, as Catalan is not recognized as an official language. In addition, they do not necessarily speak Spanish as a second language. Hence, this is one of the limitations of the present study, and a separate study should be conducted to test whether the current adaptation of the CAT to Catalan is suitable for assessing them.

5.4. Bilingualism

As previously mentioned, all the individuals who participated in the present study were bilingual speakers of Catalan and Spanish. There is extensive literature showing that bilingualism is one of the factors that influences the performance on language tests, also in aphasia (among others, Paradis & Libben, 1987; Egia-Zabala & Munarriz-Ibarrola, 2024; Fyndanis, Cameron, Bonnevie Hansen, Norvik, & Gram Simonsen, 2022). In fact, in contexts in which the second language is understood, as in this case, language-mixing behaviors are considered normal even in language disorders (Fyndanis & Lehtonen, 2021). This type of behavior is one of the challenges in assessing speakers of minoritized languages, as they are usually heavily exposed and/or educated in a second language, as is the case for Catalan speakers. Thus, we examined whether there were interferences from their second language throughout the tasks to determine whether bilingualism had an impact on the performance of the participants, and in order to establish a baseline for distinguishing typical from potentially pathological language-mixing responses in Catalan-speaking individuals with aphasia.

As described in section 4.3, errors only involved five items in the picture naming subtest. Participants did not reply in most cases, but in five instances, they produced responses in Spanish. Interestingly, the only non-cognate target words among these items were the two for which Spanish responses were produced (e.g., *granota/rana* and *papallona/mariposa*). Although the number of errors is very low, this may suggest that lexical distance could play a role in occasional interference, but further data would be needed to confirm this. In the verbal fluency subtests, on the other hand, most of the errors made by the participants involved the production of Spanish words. For instance, these accounted for 33.72% and 78.79% of the errors in the semantic and phonological categories, respectively. This suggests that tasks requiring rapid lexical access may be more susceptible to cross-linguistic interference, even in healthy bilinguals.

Other production subtests, such as word repetition tasks (including the writing-to-dictation and reading subtests), involved a very low number of errors and none of the responses were in Spanish. These results reflect the careful adaptation process undertaken for these subtests, which enabled us to avoid problematic items and minimize interference from the second language. Interference from Spanish was also observed at different levels in the description subtests. The most extreme case concerned an individual who preferred to write the description in Spanish, as she had never learned to write in Catalan. Yet, in other cases, it only involved isolated Spanish words or expressions, which are common for some speakers to use when speaking Catalan. It must be noted that some of these interferences could be considered loanwords (e.g., *mando* for *comandament* ‘remote’) and should not be penalized. One of the advantages of using carefully designed tasks to assess oral production in bilinguals, such as the description tasks, is that it is easier to control for these types of responses beforehand and include them in the instructions for scoring and interpretation of results.

Despite the fact that interference from their second language is more observable in subtests that assess production, it could also have influenced their responses in comprehension subtests. For instance, in the spoken word comprehension task, half of the total errors involved confusing the target word *canell* ‘wrist’ with the phonological distractor *camell* ‘camel’. Both words are low-frequency, and the first one is a non-cognate, whose version in Spanish –*muñeca* ‘wrist’– is often borrowed by Catalan speakers when informally speaking in Catalan. The fact that the very few errors observed involved non-cognates is consistent with the literature that showed, for example, that cognates facilitate lexical retrieval in naming tests even in clinical populations (e.g., [Marte, Peñaloza, & Kiran, 2023](#)).

Overall, responses in Spanish or errors induced by interference from the second language were very low in most subtests, which indicates that the adaptation is suitable for assessing the linguistic abilities of Catalan-speaking individuals, regardless of their second-language competence. This also highlights the importance of careful adaptation processes that avoid direct translations ([Ivanova, Kuptsova, & Dronkers, 2017](#); [Martínez-Ferreiro, Arslan, et al., 2024](#)). Given the characteristics of our sample, the norms presented for the CAT–CAT do not favor monolingual speakers –a common concern in assessments of minority-language speakers, who are often bilingual. Our results suggest that language-mixing or code-switching behaviors at the lexical level in Catalan-dominant individuals with aphasia are mostly limited to verbal fluency and description tasks. Contrary to claims in the literature (see [Fyndanis & Lehtonen, 2021](#) and references therein), a high proportion of interference from the second language may indicate a pathological behavior, regardless of whether the interlocutors understand it or not, as shown by the control participants’ performance.

5.5. Cross-linguistic comparability

As already stated, one of the goals is to develop a tool that allows us to compare across languages, for both research purposes and the assessment of bilingual speakers ([Fyndanis et al., 2017](#); [Martínez-Ferreiro, Arslan, et al., 2024](#)). For instance, [Matić](#)

[Škorić, Norvik, Kuvač Kraljević, Roste, and Gram Simonsen \(2023\)](#) already compared the Croatian and Norwegian adaptations of the CAT and their findings revealed that, apart from sociodemographic variables, such as education level, the differences between the two groups of people with aphasia were due to differences in language structure. In a preliminary study, [Salmons and Muntané-Sánchez \(2023\)](#) assessed one individual with fluent aphasia using the Spanish ([Martínez-Ferreiro, Quique, et al., 2024](#)) and Catalan versions of the CAT, and also found that the main differences between the responses in Spanish were attributable to structural differences. Specifically, the participant performed more poorly in Spanish only on those tasks that included a greater number of derived and compound nouns, and on the digit span task, which could also be related to the linguistic structure, considering that most numbers in Spanish are two-syllable words, whereas Catalan numbers are mostly one-syllable words (e.g., *set* [ˈset] vs *siete* [ˈsje.te] ‘seven’). The possibility of cross-linguistic comparability among different versions of the CAT is especially interesting for assessing Catalan-speaking individuals, given that they are often bilingual speakers.

5.6. Writing assessment

The written subtests were the domain in which participants experienced the greatest difficulties. In the copying, naming and writing-to-dictation subtests, the results showed greater variability ([Table 7](#)), especially when compared to reading tasks, which also involve culturally mediated behaviors but were less affected. This is probably due to the fact that, as previously mentioned, the scoring system evaluated the spelling, which is highly dependent on the participant’s knowledge of orthography. Yet, formal instruction of Catalan in Spain began to be introduced in the 1980s. In addition, Catalan orthography is not fully transparent, which explains why most misspellings consisted of phonetic errors. A significant difference was also observed between performance on the written and oral picture descriptions, as the participants performed better on the latter ([Table 8](#)). While inter-subject variability was present in both modalities, scores differed notably in the form variables, which evaluate grammaticality and grammatical complexity ([Table 9](#)). This reluctance was not due to a lack of grammatical competence, but rather from the historical absence of Catalan in formal education. Despite being informed that orthography was not scored, many preferred to provide minimal descriptions, which were characterized by little grammatical complexity and compromised grammaticality (see an example in [Appendix B](#)).

These results reflect the sociopolitical context of Catalan as a minoritized language, rather than the typical language-mixing behavior discussed earlier. For instance, according to the most recent language use survey published by the Catalan Government with data from 2023 ([Direcció General de Política Lingüística, 2025](#)), more than eight thousand Catalan residents self-reported greater competence in speaking Catalan than in writing it. The difference is notable among people older than 70: between 70% and 80% say they can speak Catalan (compared to almost 100% who speak Spanish), whereas fewer than 50% affirm that they can write it

(compared to 85–95% for Spanish). Although the survey includes individuals with varying linguistic backgrounds, it provides a general picture consistent with our findings: performance on the written descriptions was significantly worse than on spoken descriptions, and age was significantly associated with the scores on written (but not oral) descriptions (Fig. 7). Moreover, educational level was not a strong predictor of written performance, likely because higher education does not entail formal instruction of Catalan.

Our findings therefore reveal that the writing skills of Catalan-speaking individuals are strongly influenced by political and sociocultural circumstances related to the minoritized status of the language. These factors are often overlooked in studies on minoritized languages and language mixing, and they are not merely the result of individual choice or communication strategies. They also suggest that writing assessment in Catalan-speaking communities may be less reliable for diagnostic purposes than oral modalities. This is of particular relevance considering that previous research has shown that the assessment of writing abilities in monolingual individuals with aphasia can be more sensitive for diagnostic purposes and can also be useful as a rehabilitation technique (Behrns, Wengelin, Broberg, & Hartelius, 2009; Vandenborre, Visch-Brink, van Dun, Verhoeven, & Mariën, 2018). In light of this, it may be clinically relevant to consider administering written tasks in Spanish for Catalan-speaking individuals, particularly when Spanish is the language in which they have received more formal education.

It is worth noting that the political status of minoritized languages is often unstable. For instance, in 2021, the use of Catalan as a vehicular language in schools in Catalonia was limited to 75% of teaching time following a Supreme Court ruling (Branchadell, 2023), and the Government of the Balearic Islands has recently introduced a free-choice language policy, which means that Catalan will no longer be a mandatory vehicular language in schools from 2025. Effective language normalization policies are essential for protecting minoritized languages that coexist with majority languages. The predictable outcome of weaker policies is a progressive substitution that will ultimately affect all linguistic levels, especially among populations with language disorders, who already face challenges accessing care in minoritized languages. The availability of assessment tools in these languages is a key step in addressing this issue.

6. Conclusion

Here we have presented the adaptation of the *Comprehensive Aphasia Test*, originally developed in English by Swinburn, Porter, and Howard (2005), into Catalan (Salmons et al., 2021). The main goals were to adapt a tool specifically designed to assess and diagnose aphasia into Catalan and to provide normative data. The adaptation took into account the psycholinguistic properties considered in the original test, such as frequency or imageability, as well as language-specific factors. Moreover, we also reported the results from 110 Catalan-speaking individuals to establish normative data. Our findings allow us to establish the range of non-pathological performance and cut-off scores, which are crucial for future

studies to determine the sensitivity of the test to discriminate language deficits from normal performance. All the participants were bilingual speakers of Catalan and Spanish. Therefore, the norms established in the present study for Catalan are not biased in favor of monolingual speakers, which is an issue in the assessment of minority languages often pointed out in the literature (e.g., Goral, Norvik, Antfolk, Agrotou, & Lehtonen, 2023). This also enabled us to examine the influence of the second language during the assessment, which was mostly evident in the production subtests.

However, this is one of the few studies that examines the general linguistic abilities of Catalan-speaking participants by focusing on their dominant language rather than treating them primarily as bilingual individuals. This is of particular interest considering that it is a minoritized language. Hence, the CAT is also a research tool that expands the investigation to languages other than English, which are less researched in aphasiology. Studying minoritized languages can be informative not only in terms of differences across language structures but also regarding sociocultural factors that influence language use and the diagnosis of linguistic deficits. For instance, the results of the present study revealed that the subtests evaluating writing skills are less reliable than those assessing oral abilities, due to the specific sociocultural context of many Catalan speakers, who have not received formal instruction in their mother tongue. A future line of research could focus on the differences in writing between Catalan and Spanish among bilingual speakers, particularly those with varying access to formal education in Catalan, taking into account the different educational models across Spain and across generations. Such studies would bring to light the usefulness and limitations of the CAT–CAT and similar tests to diagnose language disorders in speakers of minoritized languages.

As discussed earlier, one limitation of this study is that it only included participants from Spain and Andorra, whose second language was Spanish. Future studies should include Catalan-speaking individuals from Italy and France, where Catalan is not an official language and its presence is more limited. These individuals speak dialects that were not considered during the adaptation process or in the normative study, and they do not necessarily speak Spanish. Given the sociocultural circumstances, which differ markedly from those of the Catalan-speaking participants in this study, substantial differences in responses and a high level of interference from their second languages would be expected, potentially resulting in significant changes to the CAT–CAT.

Therefore, the CAT–CAT is the first tool to comprehensively examine language across modalities in Catalan-speaking adults, which is not only useful for diagnostic purposes but also for determining their linguistic profile, which is crucial for designing more effective interventions and for monitoring recovery. It also contributes to the goal of developing a tool in multiple languages (Arslan & Peñaloza, 2025), both for research and clinical purposes. Furthermore, the CAT–CAT also serves as an instrument to investigate language skills in typical ageing in an understudied language, as well as the impact of other factors, such as education. Our findings revealed that age was a more relevant factor in explaining the variability in certain subtests than education level. For

instance, increasing age significantly correlated with decreased performance on several subtests, such as verbal fluency or written descriptions. This also opens the possibility of using it to study Catalan-speaking individuals with other types of language disorders; indeed, the CAT-CAT has already been used in preliminary studies with people with cognitive impairment (Salmons et al., 2024) and primary progressive aphasia (Salmons & Muntané-Sánchez, 2025). Future work will focus on validating its sensitivity in individuals with aphasia, a crucial step for distinguishing pathological from non-pathological language behavior, as well as studying its psychometric properties.

CRediT authorship contribution statement

Io Salmons: Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Helena Muntané-Sánchez:** Writing – review & editing, Resources, Methodology, Formal analysis, Data curation, Conceptualization.

Research data

Research data for this article can be found online at <https://doi.org/10.34810/data2416>.

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A Structure of the CAT-CAT

The complete list of the subtests included in the Catalan version of the *Comprehensive Aphasia Test* (Swinburn et al.,

Table A1 – Subtests of the CAT-CAT

COGNITIVE SCREEN	
1	Line bisection
2	Semantic memory
3	Word fluency
4	Recognition memory
5	Gesture object use
6	Arithmetic
LANGUAGE BATTERY	
7	Comprehension of spoken words
8	Comprehension of written words
9	Comprehension of spoken sentences
10	Comprehension of written sentences
11	Comprehension of spoken paragraphs
12	Repetition of simple words
13	Repetition of complex words
14	Repetition of pseudowords
15	Repetition of digit strings (digit span)
16	Repetition of sentences (word span)
17	Picture naming of objects (oral)
18	Picture naming of actions (oral)
19	Spoken picture description
20	Reading of simple words
21	Reading of complex words
22	Reading of function words
23	Reading of pseudowords
24	Writing: Copying
25	Writing picture names
26	Writing to dictation
27	Written picture description

2023; Swinburn, Porter, & Howard, 2005) is in Table A1. The materials to administer the test have been published in Salmons et al. (2021). In Table A2, the variables included in the scoring system of the description tasks are described. A more detailed explanation of the scoring system of the CAT-CAT and the preliminary data from a study with people with aphasia and cognitive impairment is in Salmons et al. (2024).

Table A2 – Scoring system of the description tasks

Variables	Description
CONTENT	
Nouns	Number of relevant characters or objects produced
Verbs	Number relevant actions produced
Events	Number of relevant events produced
FORM	
Fluency	0 (consistent and significant delay), 1 (frequent and significant delay), 2 (occasional delay), 3 (without delay)
Grammaticality	0 (absent), 1 (weak), 2 (medium), 3 (good)
Complexity	0 (mutism, stereotypy), 1 (one syntactic structure, list), 2 (2 syntactic structures), 3 (3 or more syntactic structures)

(1)	Original: Sembla que l'avia s'ha quedat dormida mentre llegia, el gat aprofita per enfilarse per les estanteries i tira tots els llibres i va de cap a la peixera. El nen que està jugant intenta avisar-la pero es dormida i no se'n assebeta.	Translation: It looks like the grandmother has fallen asleep while reading, the cat takes the opportunity to climb up the shelves and knocks down all the books and heads straight to the fish tank. The child who is playing tries to warn her but she is asleep and doesn't realize.
(2)	Original: el gat tiran els llibres flors estanteria CD Nen jogan Dona dormin Butaca Tauleta amb llibres Planta Peixera equip de musica Fotos	Translation: The cat knocking down the books Flowers CD shelf Child playing Woman sleeping Armchair Small table with books Plant Fish tank Music system Photos

B Examples of responses

B.1 Written description

Examples of the written descriptions by a 58 year-old (1) and a 59 year-old (2), both with a basic level of education.

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