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Quantitative and Qualitative Aspects of Factors and Forms of Aphasia: Clinical Data

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Количественные и качественные аспекты факторов и форм афазии: клинические данные

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Abstract. There is no single valid method covering all the clinical and research needs of aphasia assessment. The classic controversies about the qualitative and psychometric approaches to this condition should be finally overcome. In this article, firstly, the metric characteristics of the test variables employed in the study of aphasia are investigated. Second, a psychometric/categorical method is proposed to resolve the limitations of these metrics. Finally, the psychometric/categorical method is illustrated through the particular aspects of three clinical cases. The contributions of the method, and the problems of the factors and forms of aphasia, are discussed.

Keywords: *neuropsychological testing; psychometrics; qualitative assessment*

Аннотация. Не существует единого метода, который подходил бы для всех клинических и исследовательских нужд оценки афазии. Классические споры о качественном и психометрическом подходе к афазии должны быть полностью завершены. В данной статье, во-первых, исследуются метрические характеристики переменных тестов, используемых при изучении афазии; во-вторых, предлагается психометрический/категориальный метод для преодоления ограничений метрик тестовых переменных. Психометрический/категориальный метод проиллюстрирован тремя конкретными клиническими случаями. Обсуждаются вклад метода и проблемы факторов и форм афазии.

Ключевые слова: *нейропсихологическое тестирование; психометрия; качественная оценка*

Introduction

In neuropsychology, and specifically in aphasiology, there is an old controversy about qualitative versus quantitative methods of assessment (Akhutina & Melikyan, 2012; Glozman, 1999a, 1999b, 2002, 2006; Luria, 1970, 1973a; Luria & Majovski, 1977; Mikadze, 2011). This kind of "simplistic" or false dichotomy (Peña-Casanova, 2021) has obvious limitations because there is not one single method valid for all clinical or research issues (Glozman, 2002; Lezak, Howieson, Bigler, & Tranel, 2012). Standardization procedures are considered the core of reliability assessment in neuropsychology (Lezak et al., 2012).

Historically aphasia classification has been based on a qualitative approach: aphasia syndromes are characterized thanks to dissociations among different linguistic, cognitive, and neurological capacities (Lecours, Poncet, Ponzio, & Ramade-Poncet, 1979). It is also evident that symptoms (semiology) are critical in understanding the observed dissociations (Lecours & Lhermitte, 1979). In Luria's approach the assessment aim was the definition and "qualification of the deficit" (the *Grundstörung* [basic disorder] of Goldstein) (Goldstein, 1925; Luria, 1970). This kind of proposition was considered similar to factor analysis (Luria & Majovski, 1977).

Beyond dissociations (preserved and impaired capabilities), the French school of neuropsychology introduced a vocabulary of neurolinguistics that described qualitative aspects of aphasic symptoms (Baqué, Barbeau, Sahraoui, & Nespoulous, 2016; François & Nespoulous, 2011; Lecours, Dordain, Nespoulous, & Lhermitte, 1979). The qualitative neuropsycholinguistic description of aphasic symptoms constitutes the determining aspect of the diagnosis (Diéguez-Vide & Peña-Casanova, 2012).

Aphasiology shows that the strict dichotomy "qualitative-quantitative" does not make much sense. The same quantitative score (psychometry) in a test acquires a totally different clinical value depending on the specific symptoms (semiology) observed. As much as this paper focuses on the issue of "psychometry", semiology is inextricably linked to it. Finally, it is important to remember that cultural values always underlie the psychometric approach, especially in the case of language (Ardila, 2005). Consequently, the point is how to incorporate psychometric approaches to qualitative syndromes. The evaluation of language involves very different concepts and methods depending on the theoretical view and the practical needs of the authors.

Objective

The objective of this paper is threefold: (1) To study the metric characteristics of the tests used for the clinical evaluation of aphasias; (2) To define a methodology that allows overcoming the statistical limitations of test variables; and finally, (3) To illustrate and discuss the proposed methodology and the factors and forms of aphasia.

Methods

The methods differ according to the three objectives of the study: (1) Definition of the characteristics of the variables of language by reviewing the main aphasia tests. (2) Definition of a new methodology for the evaluation of aphasia based on the study of 100 cases. (3) Illustration and discussion of the proposed method through the selection, *ad hoc*, of three clinical cases: a phonological aphasia, a pure anomia, and a case of two-way anomia.

Development

Metric Characteristics of Aphasia Test Variables

For the definition of the metric characteristics of the variables of the aphasia tests, the following approaches and tools have been selected: (1) Luria's basic postulates, testing, and functional "model" (Luria, 1970, 1973b, 1975), and its "quantitative" formalization (Glozman, 1999b, 2006). (2) The "model" of the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass & Kaplan, 1974; Goodglass, Kaplan, & Barresi, 2001). (3) The Psycholinguistic Assessment of Language Processing in Aphasia (PALPA) (Kay, Lesser & Coltheart, 1992).

(1) Luria's postulates and methods are described in detail in his book on traumatic aphasia (1970). Each test has the objective of assessing particular components of the complex functional system of language. The tests therefore have specific psychological and neurological (topographic) diagnostic objectives (Luria & Majovski, 1977).

In the field of Lurian neuropsychology, Glozman (1999a, 1999b, 2006) defined a method of quantification of the neuropsychological symptoms observed in the neuropsychological examination. This method allows the assignment of scores (0 — 0.5 — 1 — 1.5 — 2 — 3) to types of symptoms graded by severity. In fact, this quantitative method is based on descriptive qualitative categories. This means that the variables become "ordinal" since the categories are graded by a theoretical (not empirical) severity. In this regard, Glozman's method is similar to certain BDAE tests such as the severity scale that establishes a graded scale of six ordinal categories (from 0 to 5).

(2) The BDAE model has three aims: "*(1) diagnosis of presence of any type of aphasic syndrome that leads to inferences concerning cerebral localization and underlying linguistic processes that may have been damaged […]; (2) measurement of performance over a wide range for both initial determination and detection of changes over time; (3) comprehensive assessment of the patient's assets and liabilities in all language areas as a guide to therapy*" (Goodglass et al., 2001, p. 1). The general scoring method is pass or fail, 1 point per correct item. In certain tests, however, the score is adjusted to allow for delay in responding (e. g., responsive naming approximate time to respond: 1–5 s. = 2 points; > 5 s. = 1 point; fail = 0 points).

In order to overcome the issue of aphasia tests in normal subjects who show ceiling scores (maximum scores), the authors decided to take a group of aphasics as reference. Such a decision, however, had the accompanying complication of the inclusion and exclusion criteria considered (type of aphasia, severity, location of the lesion, time of evolution, etc.). Depending on the group studied, the pathological reference would vary greatly. Furthermore, each time the reference sample was modified, the test scores would be modified accordingly.

There is still another more serious complication: how to report test results? In the first edition of the BDAE (Goodglass & Kaplan, 1974), test results were described as means and standard deviations. This was an error since the descriptive statistics of a group of unselected aphasics shows a bimodal distribution. This is so because aphasias present a series of dichotomies (e. g., cases with preserved repetition vs. cases with impaired repetition; cases with preserved compression *vs.* cases with impaired comprehension) that lead, at a minimum, to bimodality. To overcome this problem, in the second edition of the BDAE (Goodglass et al., 2001) percentiles were introduced as a quantification method.

When an aphasia battery contains tasks such as a fluency test (e. g. animal names in one minute), or complex constructional praxis tests, then normative groups and psychometry are required (Peña-Casanova, Blesa et al., 2009; Peña-Casanova, Quiñones-Úbeda, Gramunt-Fombuena, Aguilar et al., 2009; Peña-Casanova, Quiñones-Úbeda, Gramunt-Fombuena, Quintana-Aparicio et al., 2009).

(3) The Psycholinguistic Assessment of Language Processing in Aphasia (PALPA) is based on a psycholinguistic processing model (theoretical functional architecture). The model includes "boxes" (processors) and "arrows" (connectors), which represent postulates about language function. Beyond anatomy, the resulting test tries to study

each particular component of the model. As the model variables are dichotomous (again maximum scores are expected here), the group of normal controls consisted of 40 subjects. As the intention of the test is to detect problems in specific components of the model, the approach is absolutely qualitative and Lurian. The main difference between the cognitive approach and Luria's is that the latter focuses on complex funcional systems.

In summary, there are two types of language test variable metrics: dichotomous and distributed (Koziol & Budding, 2009; Peña-Casanova, 2021). The characteristics of these variables will be briefly discussed in the following paragraphs.

Dichotomous variables (or "almost" dichotomous) are those in which a maximum (ceiling) or complete performance is expected in all normal subjects, that is to say, a constant score (Peña-Casanova, 2019, 2021). These tests are considered dichotomous (normal *versus* abnormal = qualitative variable), or pathognomonic (errors are indicative of brain disorders). This kind of variables have been described as Lurian as they are characteristic of the type of test used mainly by Luria's qualitative neuropsychology (Koziol & Budding, 2009). The expected constant score confers the category of "quality" to the variable. There are many tests that meet these characteristics, for example: repetition, naming of parts of the body or very common objects in daily life.

Within the scope of the dichotomy, some nuances can be recognized. Depending on the sociodemographic characteristics of the subjects studied, the "dichotomous" characteristics of a variable may be "non absolute." Thus, there are cases in which a marked ceiling effect is observed, without the scores being strictly constant. These variables can be classified as qualitative, almost dichotomous, and can be assimilated to the previous ones.

The repetition of pseudowords is an example of such a type of test (Sánchez, Peña-Casanova, Cáceres, Quiñones-Úbeda, & Rivera, 2019). This variable is absolutely dichotomous in young subjects, while in older ones it is "quasi-dichotomous" (some errors are possible and may lack clinical value) which implies the need for normative specifications. The work of Roselli, Ardila, Florez, and Castro (1990) lie in the same direction. The youngest normative groups (regardless of schooling level) show a dichotomous score (ceiling — 10). Older subjects (over 60 years), present scores of 8 and 9 in the 10th and 20th percentiles, respectively. In this case the score is not ceiling. Consequently, scores 0–7 would fall below the 10th percentile.

A series of ordinal qualitative variables are also dichotomous. Such variables are determined, "by author's criteria," through descriptive characteristics that have been ordered to establish an intensity scale. As previously commented, a typical example is given by the BDAE and TB-2 aphasia severity scales (Peña-Casanova, 2019; Peña-Casanova, Diéguez-Vide, Sigg, & Conesa, 2019). In this case, all normal subjects must, by definition, fall into the "normal" category. The rest of the severity categories indicate and "measure" the intensity of the aphasic disorder.

Conversion of dichotomous (Lurian) variables into Gaussian variables. In certain cases, item selection causes a variable to change from being dichotomous to Gaussian.

Thus, if a naming test includes typical and frequent elements of daily life (dog, cow, hand, eye, etc.), the expected scores will be complete (maximum, ceiling). In contrast, if a picture naming test includes elements belonging to different frequency ranges (high, medium, and low), and of differentiated cultural knowledge, the result will be a test with a distribution of scores, probably Gaussian. The typical example of this is represented by the BNT (Kaplan, Goodglass, & Weintraub, 1983, 2001). For this reason, the BNT requires adequate standardization and sociodemographic adjustments of the observed scores (Peña-Casanova, Quiñones-Úbeda, Gramunt-Fombuena, Aguilar et al., 2009). The same phenomenon is observed in constructional praxis tests: in all cases schooling (years) must be considered, including the cases of relatively "easy" items. In these cases, psychometry is mandatory.

Distributed variables. These variables show a normal or Gaussian distribution that is not necessarily perfect (negative or positive asymmetries). Scores are expressed as means, deviations, percentiles or scaled scores (ordered groups of percentiles). In many cases, moreover, raw scores are adjusted for sociodemographic factors such as age and education. For example, the BNT, as previously commented, must be adjusted for sociodemographic factors such as age and education. There are many tests that meet these characteristics, for example: semantic (e. g., animals) and category (e. g., words beginning by the sound "p") fluencies, the BNT, Stoop Test, Trail Making Test, Rey-Osterrieth Complex Figure, Free and Cued Selective Reminding Test. Obviously, psychometrics must be complemented by a qualitative analysis, such as Luria's method, or the Boston process approach (Kaplan, 1983; Werner, 1937). Psychometric scores alone without "qualification" make no neuropsychological sense.

The Psychometric-Ordinal Method (Categorical Grading of Pathology)

In order to overcome the "dichotomous jump" of ceiling variables in normal subjects, a psychometric-ordinal method was developed. The solution was based on the bimodal distribution of aphasic scores, taking as reference the repetition of words (Bilbao, García, & Torres, 1990; Peña-Casanova, Böhm, Villaseñor, Guardia, & Manero-Borrás, 2005).

Bimodality reflects the dichotomous axes that allow aphasic syndromes to be roughly classified, e. g., verbal expression, comprehension, repetition, and naming (Ardila & Roselli, 2019). Considering the data from the word repetition test, and for a variable with a range 0–10, a graded series of categories (inspired by Leyton, Ballard, Piguet, & Hodges, 2014) of impairment was defined (*Fig. 1*).

The maximum possible score [10] defines normality [N] (expected ceiling score in normal subjects). The following score [9] can have two meanings: L–Q (borderline [limit] — questionable), or L1 (Mild 1). L–Q, means loss of a single point without clinical significance (by definition). In the case of variables such as oral comprehension of parts of the body, which has an absolute ceiling [10], a single failure was considered mild and a score of 9 was located at L1. The G (severe [*gravis*]) score [0–4] was defined as follows: maximum possible score [10] divided by two and then one point subtracted [= 4]. It was considered that in such simple tasks, not responding correctly to 50 % of the items signified a serious impairment.

In order to differentiate the zero score, G (gravis) was divided into G1 (4–1 scores) and G2 (zero score). Category L2 (mild 2) is defined by scores 8 and 7, while categories M1 (moderate 1) and M2 (moderate 2) are defined by scores 6 and 5 respectively. The defined categories are represented in the summary profile of the tests. The design allows the differentiation of L1 from L–Q in two different columns. Category N is located on the right, with a space ("jump") represented by grids in which, if applicable, are the percentiles (from left to right: 80, 70, 60, 50, 40, 30, 20, 10 [L–Q]). N represents the percentile equal to or greater than 90, while L–Q represents the 10th percentile, or one error in the case of the non-strictly dichotomous Lurian tests. This information will be further discussed in the clinical cases section.

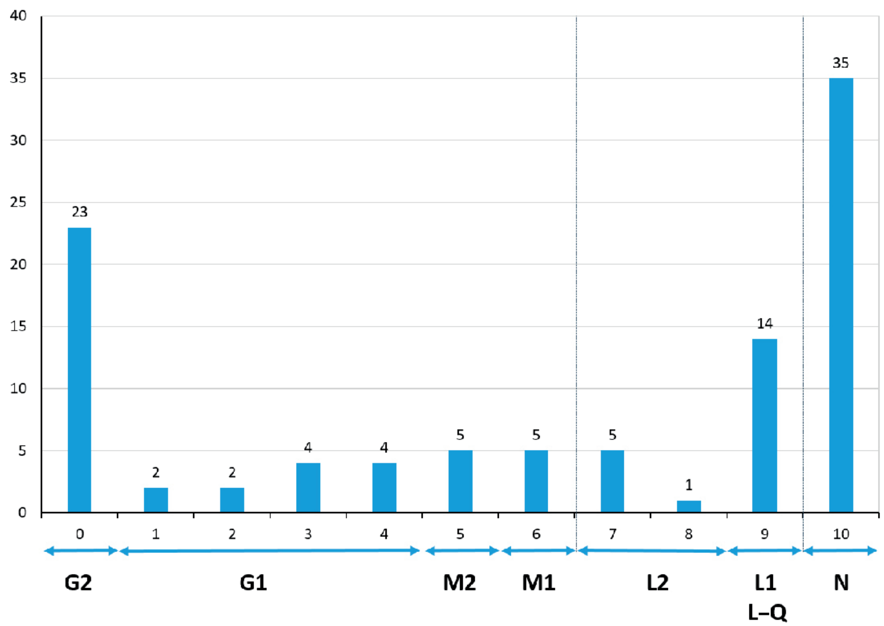


Figure 1. Bar charts of the word repetition test scores in cases of aphasia ($n = 100$). The observed distribution was bimodal. Below, and delimited by arrows, the defined psychometric categories are shown. Letter codes (from Latin language) are the following: N = normalis, normal, maximum score; L1 = levis, mild 1 / L–Q = borderline (limbus, limit) — questionable; L2 = levis, mild 2; M1 = moderatus, moderate 1; M2 = moderatus, moderate 2; G1 = gravis, severe 1; G2 = gravis, severe 2, maximum impairment, zero score

Some Illustrative Clinical Cases

We present below three illustrative cases of the psychometric-ordinal report of particular features of aphasia. We will successively depict a phonological aphasia, a pure anomic aphasia, and a semantic anomia. All language examinations were carried out with the Barcelona Test.

Phonological aphasia. Case report. A 45-year-old man (PMDC) with higher education was diagnosed with a left parietal glioma (*Fig. 2*). The patient did not report any significant cognitive disorder, except being "tired and forgetful." A few months before, he had presented a right paresis. The purpose of the consultation was to carry out a study in order to plan neurosurgery (cortical electrical stimulation and monitoring of language during surgery).

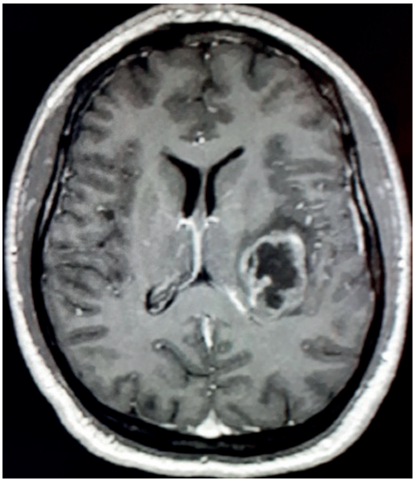
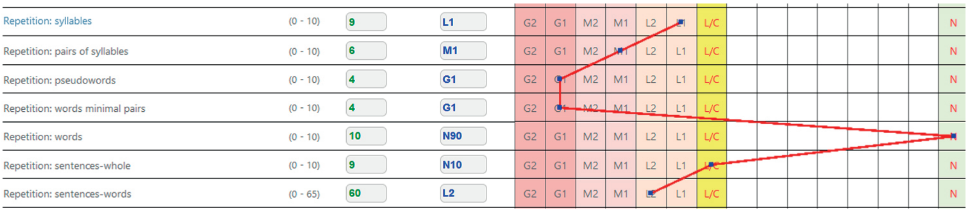


Figure 2. Left parietal (posterior insular) glioma with cortical and subcortical involvement affecting the internal capsule. Vasogenic edema and mass effect that discreetly deforms the anterior ventricular horn and occludes the posterior one

Impairment focused on repetition was observed (*Fig. 3*). The results were the following: syllables (9/10, mild), pseudowords (4/10, severe), words of minimal pairs (4/10, severe), pairs of syllables (6/10, moderate). The phenomenon of lexicalization was reported. In contrast, the repetition of words was normal (10/10), and the repetition of sentences showed a good performance (9/10), with one failure in a single sentence (of 10 words). Reading, including pseudoword reading and pointing, was absolutely normal. In contrast, pseudoword dictation was significantly impaired (4/10, severe). Word dictation and written naming were normal.

This ipsative dissociation is typical of phonological aphasia (mistakes focused on the repetition of pseudowords and assimilated elements). Comprehension was normal.

The observed pattern has a double value: on the one hand, the value of the scores *per se* (psychometry), and, on the other, the set of dissociations shown (specific problem of repetition). In other words, the profile has a quantitative diagnostic value (scores) and a qualitative one (the affected tests). Beyond the profile, however, the specific symptomatology was characterized by errors in phonemic seriation/discrimination of structures devoid of semantics (pseudowords, pairs of syllables), and in discriminatory tasks in which semantics remained as a secondary element (minimal pairs). This is the typical pattern of a phonological aphasia.

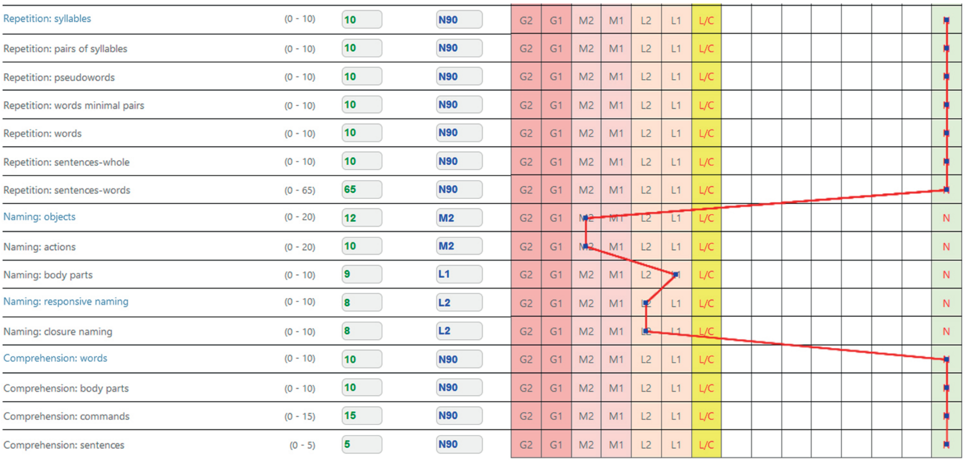


Repetition: syllables	(0 - 10)	9	L1
Repetition: pairs of syllables	(0 - 10)	6	M1
Repetition: pseudowords	(0 - 10)	4	G1
Repetition: words minimal pairs	(0 - 10)	4	G1
Repetition: words	(0 - 10)	10	N90
Repetition: sentences-whole	(0 - 10)	9	N10
Repetition: sentences-words	(0 - 65)	60	L2

Figure 3. Phonological aphasia repetition tests. Columns, from left to right: (1) Name of the test. (2) Possible range of scores. (3) Score obtained by the patient. (4) Category corresponding to the score obtained (result of the application of categorical rules). (5) Graphical representation (profile) of the scores shown in columns 3 and 4. The empty squares represent, if relevant and from right to left, the 20th, 30th, 40th, 50th, 60th, 70th, 80th percentiles

Phonological aphasia, also called auditory-phonological agnosia, is characterized by a disorder in the repetition of pseudowords, but a preserved repetition of words. Lexicalizations are frequent, i. e., the patient does not repeat a pseudoword and instead repeats a similar real word regarding the form.

Pure anomic aphasia (classical anomia): one-way anomia. Case report. A 64-year-old man (JPM) with higher education suffered a stroke related to a left inferior temporal gyrus arteriovenous malformation. He presented anomia with circumlocutions and omnibus words. He occasionally produced semantically related names that were rejected as incorrect. Repetition and verbal comprehension were normal. An impairment focused on naming was observed (*Fig. 4*).



Repetition: syllables	(0 - 10)	10	N90
Repetition: pairs of syllables	(0 - 10)	10	N90
Repetition: pseudowords	(0 - 10)	10	N90
Repetition: words minimal pairs	(0 - 10)	10	N90
Repetition: words	(0 - 10)	10	N90
Repetition: sentences-whole	(0 - 10)	10	N90
Repetition: sentences-words	(0 - 65)	65	N90
Naming: objects	(0 - 20)	12	M2
Naming: actions	(0 - 20)	10	M2
Naming: body parts	(0 - 10)	9	L1
Naming: responsive naming	(0 - 10)	8	L2
Naming: closure naming	(0 - 10)	8	L2
Comprehension: words	(0 - 10)	10	N90
Comprehension: body parts	(0 - 10)	10	N90
Comprehension: commands	(0 - 15)	15	N90
Comprehension: sentences	(0 - 5)	5	N90

Figure 4. Pure anomic aphasia. Columns, from left to right: (1) Name of the test. (2) Possible range of scores. (3) Score obtained by the patient. (4) Category corresponding to the score obtained (result of the application of categorical rules). (5) Graphical representation (profile) of the scores shown in columns 3 and 4

The results of the test were the following: naming pictures (12/20, moderate), actions (10/20, moderate), and body parts (9/10, mild). Naming from verbal stimuli was also affected: responsive naming (8/10, mild), and closure naming (8/10, mild).

Interestingly, the verbal semantic context (response and sentence completion) improved the results. In summary, the patient was able to choose the correct object from a group of objects when given the name. In contrast he was unable to give the name of the object when it was presented in any sensory modality. Consequently, the patient presented one-way anomia (he was able to recognize the correct name offered).

The term classical anomia, was used by Geschwind (1967) to describe subjects who could not name an object but could pick the correct label from a range of possible names provided by the clinician (see Lambon-Ralph, Sage, & Roberts, 2000).

Semantic anomia: two-way anomia. **Case report.** A 25-year-old man (MMT) with higher education. He was referred for consultation due to language disorders as a consequence of a left temporo-parietal stroke. He presented fluent speech with semantic paraphasias, and mild to moderate disorder of verbal comprehension. Repetition was practically normal or of no clinical significance (words of minimal pairs: 9/10; sentences 9/10 [error in one sentence]. Naming tests presented the following results: objects, 9/20, severe; actions, 6/20, severe; body parts 0/10, severe. Naming from verbal stimuli was also affected: responsive naming (7/10, mild), and closure naming (9/10, mild) (*Fig. 5*).

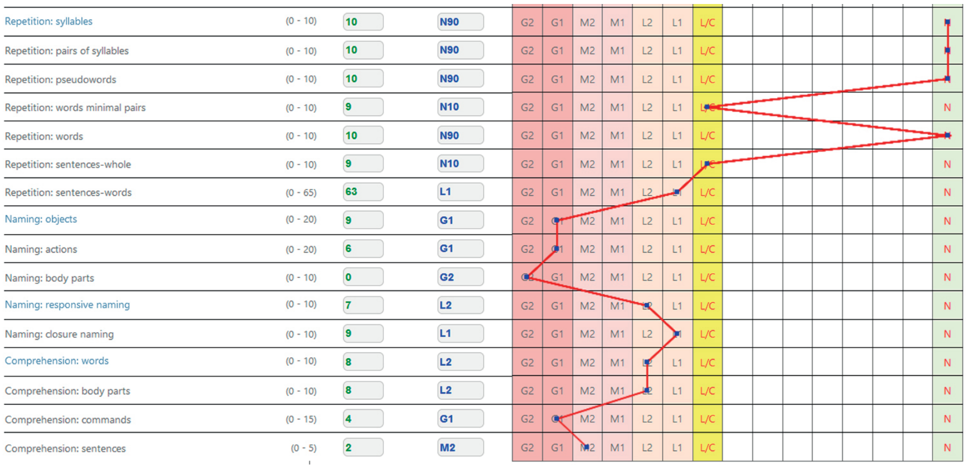


Figure 5. Two-way anomia in the context of transcortical sensory aphasia, evolution from Wernicke's aphasia. Columns, from left to right: (1) Name of the test. (2) Possible range of scores. (3) Score obtained by the patient. (4) Category corresponding to the score obtained (result of the application of categorical rules). (5) Graphical representation (profile) of the scores shown in columns 3 and 4

The patient was unable to find the target word and also presented disorder in the recognition of the correct word offered (two-way anomia). Verbal comprehension showed the following performances: words, 8/10, mild; body parts, 8/10, mild; commands, 4/15, severe; complex sentences, 2/5, moderate. In short, verbal comprehension was mainly in supralexical tasks (commands and complex sentences). The observed profile had the characteristics of a transcortical sensory aphasia with a two-way anomia.

Semantic or two-way anomia frequently occurs in transcortical sensory aphasia and Wernicke's aphasia, both "posterior" aphasias (Lecours & Lhermitte, 1979).

Discussion

Psychometry and Aphasia as a Qualitative Entity

A clinical form of aphasia defined through a test constitutes a qualitative pattern, whatever the form of examination. Psychometry adds systematization, objectivity, reliability, and comparability. Without systematization it is impossible to obtain homogeneous studies from which conclusions can be drawn. This also includes the specific contents of aphasia batteries (qualitative or quantitative, flexible or fixed). Thus, in the case of phonological aphasia depicted in our paper, the diagnosis could be made thanks to the inclusion of specific tests (pseudowords, etc.). Diagnoses such as deep aphasia (see Ellis & Young, 1988) can only be made through the specific symptoms observed in the repetition test (semantic paraphasias), and other symptomatology. In summary, the clinical profiles are not ecological since they only highlight dissociations, without referring to the symptoms. Nevertheless, in certain cases an ipsative analysis of test groups has considerable qualitative and diagnostic value (e. g., dissociations in the repetition test in the case of phonological aphasia presented here).

Quantification in Aphasia

For clinical and research needs quantification of the observed aphasic disorders is crucial. For example, an occasional anomia is not the same as a severe and limiting one. Nor is it the same to observe a slight disorder in verbal comprehension as to detect a practically abolished one. The key issue is how to quantify aphasic patterns since the vast majority of tests show a ceiling effect in normality (hence the qualitative or dichotomous variables).

The initial correct approach (reference aphasic group) of the Boston test (BDAE) was erroneous since z scores were applied for the graphic representation of the results. For this reason, the second edition of the BDAE changed the representation of the results to percentiles. Although percentiles have been criticized (Bowman, 2002), they are probably the best way to express psychometric results in neuropsychology (Crawford & Garthwaite, 2009).

The psychometric-ordinal method allows the systematic transformation of real scores (number of errors) into ordinal categories. The ordinal grading was carried out from the bimodal characteristics of the distributions of the scores of a group of 100 aphasias. The resulting graphs are similar to those defined by the previously developed percentile distribution (Peña-Casanova et al., 2005). This is of particular importance because it permits the avoidance of aphasics as a control group. In contrast, Glozman's quantification method is based directly on the categorization and grading of the observed behavior, not on the psychometric number of errors.

The profiles of the cases presented in this paper show that it is possible to observe dissociations and severities of neuropsychological disorders. Obviously, profiles make sense if the semiological (symptomatic) features that characterize them are considered.

Aphasia Underlying Cognitive Processes and their Neural Substrates. Aphasia Factors

Interpretation of the relationships among clinical tests, the processes they measure, and the brain systems underlying them, is critical in order to move beyond aphasia syndrome classification towards specification of individual language process impairments (Lacey, Skipper-Kallal, Xing, Fama, & Turkeltaub, 2017). In fact, the two aspects of the issue are the test results and the cognitive processes and their biological correlates. Thus, the following questions arise: What is the affected factor or process behind the observed syndromic aphasia pattern? Can aphasias be explained by a single deficit factor?

The complexity and symptomatic diversity of most aphasic syndromes makes a simple and mono-factorial explanation difficult. For example, Broca's aphasia shows the following major symptoms: reduction with anomia, phonetic disintegration, and agrammatism. These symptoms, which can be dissociated into pure forms such as agrammatism, can hardly have a single determining factor. The same problem occurs in the case of Wernicke's aphasia and its variants. In the case of anomic aphasia or semantic aphasia, there are variants that probably recognize different pathophysiologies.

Present knowledge about the biological bases of language has developed far beyond the serial processing and corticocentric view of the previous century. The introduction of the dorsal and ventral processing streams opens new insights into the interpretation of aphasic syndromes (e. g., Friederici, 2011; Hickok & Poeppel, 2004). Moreover, the current hodological and parallel processing approach adds to the possibilities of interpretation of aphasia mechanisms (e. g., Catani & Thiebaut de Schotten, 2012). Finally, the recognition of the role of subcortical structures in cognition (Koziol & Budding, 2009), and the new perspective regarding brain functional blocks beyond Luria (Peña-Casanova & Sigg-Alonso, 2020), forces change in the interpretations of factors and anatomical correlations. It has recently been shown that in the auditory cortex cortical processing across areas is inconsistent with a serial hierarchical organization, and that there exists parallel and distinct information processing in the primary and nonprimary auditory cortices (Hamilton, Oganian, Hall, & Chang, 2021).

Valdois, Ryalls, and Lecours (1989) proposed a critical analysis of the clinical forms of aphasia recognized by Luria. These authors demonstrated in what manner and to what extent the main forms of aphasia described by Luria coincide with those characterized in other widely recognized classifications.

According to Luria, sensory aphasia (acoustic-agnosic) results from an impairment of the auditory analyzer. The primary factor underlying the symptomatology of sensory aphasia was not, however, consistently characterized. He originally considered that the fundamental defect in sensory aphasia was phonemic hearing (Luria, 1970). Nevertheless, in a paper published 1977 Luria contemplated the disorder to be secondary to a certain loss of the phonematic structure of words. This last hypothesis goes far beyond the initially postulated impairment of phonemic hearing (Valdois et al., 1989). Luria's conception has been criticized by several authors because some of Wernicke's aphasics performed correctly on discrimination tasks, while others showed problems in discriminating phonological contrasts (Blumstein, Baker, & Goodglass, 1977). Luria also considered that a "disturbance of phonemic hearing obviously precludes understanding of the meaning of words" (Luria, 1964, p. 149). Although the phonemic hearing hypothesis cannot be discarded *a priori* (Valdois et al., 1989), most of the symptoms of sensory aphasia, such as reading, naming, writing, and spontaneous speech) could not be considered to derive from this kind of impairment. Recent studies demonstrate that Wernicke's aphasia reflects a combination of acoustic-phonological and semantic control deficits (see Robson, Sage, & Lambon Ralph, 2012).

Phonological aphasia (patient PMDC) shows the dissociation between the processing of meaningless verbal sounds (pseudowords) and real words (semantics). It is significant that the "phonological" symptomatology is also observed in dictation writing. This means that it is not reduced to an acoustic-phonological (oral) coding disorder, but a disturbance in phoneme-grapheme conversion also appears. It has already been commented that the grapheme-phoneme conversion (reading pseudowords) was normal.

Pure anomic aphasia (patient JPM) and semantic aphasia (patient MMT) present interesting dissociations. The "classical anomia" displays a profile of word-finding difficulties without impaired semantics or phonology, while the "semantic anomia" may express a degradation of semantic representations. In fact, semantic anomia can be seen in cases of Wernicke's aphasia as evolving into transcortical sensory aphasia. On the other hand, semantic anomia is typical of primary progressive aphasia resulting from atrophy of the temporal poles (see Peña-Casanova, 2019). According to Luria's conception, multidimensional featural matrices corresponding to words, include both semantic and phonemic features. Since Luria did not distinguish between meaning-based and form-based selection it led him to interpret both semantic and verbal paraphasias as reflecting a disorganization in semantic codes (Luria, 1973b). Recent studies report that there are different impairments of semantic cognition in semantic dementia and semantic aphasia, and there is evidence of an impairment of the non-verbal domain (Robson et al., 2012).

Conclusion

Without a quantitative approach it is impossible to perform certain types of analysis. Lacking psychometric scores the degree of deficit, and its evolution over time, cannot be determined. Psychometry allows systematization, objectivity of scores, reliability, and comparability. Many tests require a mandatory psychometric approach as performance depends on social and cultural factors such as age, sex, and education.

We have shown that when variables are dichotomous (Lurian), it is possible to perform an ordinal grading of the test scores. This gradation has been developed thanks to a pilot sample of 100 aphasics. We have demonstrated that psychometry alone (scores) does not make sense in neuropsychology. The method proposed by Glozman, although similarly ordinal, works in the opposite direction. The symptom is first qualified and then assigned a numerical category. This method, although correct, lacks the traditional psychometric model.

The same score in a test can have different factors and mechanisms in its background. For this reason, as Luria postulated, all psychometric scores must be properly qualified. The clinical cases presented in this paper exemplify the problem. On the other hand, the ipsative analysis of the test results, *per se*, can lead to the recognition of qualitative profiles with a diagnostic value. This finding is evident in the case of phonological aphasia (patient PMDC).

The proposed clinical profiles, complemented with semiology, help to recognize dissociation patterns and, consequently, facilitate diagnosis. The profiles allow the visualization of the clinical course. In addition, although not the subject of this paper, numerical ordinal categories can be taken together to obtain global scores. Such scores permit mathematical (psychometric) follow-ups in cases of neuropsychological rehabilitation and pharmacological studies.

Finally, it should be noted that the most difficult issue is to ascertain the affected factor (s) (*Grundstörung*) that determines a neuropsychological syndrome. The possibilities for analysis and clinical-biological correlation have increased as a result of new technology and recent studies. The study of aphasia, thanks to the introduction of the ventral and dorsal streams, and the new approach to functional blocks, has radically changed. Consequently, the clinical forms of aphasia described by Luria can no longer be accepted as monolithic and static facts. This in no way detracts from the immense importance of his work. Luria's brilliant and comprehensive ideas about brain function continue to open new perspectives for the further development of neuropsychology.

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