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Quantifying connected discourse in Spanish-speaking individuals with aphasia: The case of mixed aphasias

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A R T I C L E I N F O

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1. Introduction

Interest in the analysis of spontaneous speech as a method of diagnosis and classification of individuals with aphasia is far from new (Benson, 1967; Goodglass & Kaplan, 1972; Goodglass, Quadfasel, & Timberlake, 1964; Howes, 1964; Howes & Geschwind, 1964; Kerschensteiner, Poeck, & Brunner, 1972; Wagenaar, Snow, & Prins, 1975; Wepman & Jones, 1966). Since the 50s, this type of analysis has been acknowledged as very useful on the field given that disruptions in spontaneous speech are among the most prominent manifestations of aphasia, and they constitute the best reflection of the daily language-related challenges that individuals have to overcome. Spontaneous speech studies can give rise to very important issues regarding symptoms in daily verbal communication involving connected discourse, and its evaluation using relevant language assessment tools. The existence of crosslinguistic initiatives such as the CLAS project (Menn & Obler, 1990) and the Aphasiabank project (MacWhinney, Fromm, Forbes, & Holland, 2011) substantiate the validity and relevance of this type of study. Spontaneous speech analysis allows for the quantification of preserved linguistic abilities, and the qualitative distinction among distinct types of aphasic syndromes, allowing for in-depth individual characterizations at different linguistic levels, including phonology, lexicon, morphosyntax and pragmatics (Damico, Simmons-Mackie, & Schweitzer, 1995; Fox, Armstrong, & Boles, 2009; Goodglass, Kaplan, & Baressi, 2001; Prins & Bastiaanse, 2004; Spreen & Risser, 2003; Vermeulen, Bastiaanse, & Van Wageningen, 1989; Wagenaar et al., 1975).

However, the analysis of spontaneous speech presents certain challenges that are not always easy to overcome. On the one hand, it is very time consuming, complex and infrequent structures are difficult to document, and quantification is not a priori easy to establish. On the other hand, there is a bias as for the amount of information available across aphasia types and

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degrees of severity, with most existing data coming from individuals with prototypical aphasia types, mainly Broca's aphasia with agrammatism (Bastiaanse & Jonkers, 1998; Crepaldi et al., 2006; Menn & Obler, 1990; Miceli, Silveri, Romani, & Caramazza, 1989; Rossi & Bastiaanse, 2008; Saffran, Berndt, & Schwartz, 1989; Thompson, Shapiro, Li, & Schendel, 1995). However, mixed aphasias due to damage of the left middle cerebral artery are the most common type of aphasia in clinical practice and still they are severely under investigated, despite their potential to inform the brain-language relationship. The current research addresses the issue of how accurate the analysis of spontaneous speech is to pinpoint deficits in individuals with less clear diagnoses, to the inclusion of mild and moderate mixed cases, focusing on grammatical aspects of sentential measurements and the use of verbs in Spanish speaking individuals with aphasia, since these have been shown to be highly sensitive in previous research.

1.1. *Previous studies to aphasic connected speech*

Previous analyses of spontaneous speech confirm that speakers with aphasia encounter problems across three main levels: sentence, word and inflectional level. For the most part, these findings have been confirmed experimentally.

1.1.1. *Performance pattern at the sentence level in fluent and nonfluent aphasias*

At the sentence level, nonfluent aphasic speech is characterized by short and/or fragmentary utterances with frequent omissions of function words, such as prepositions, pronouns, and determiners (Menn & Obler, 1990; Miceli et al., 1989). Consequently, significantly fewer words are produced per utterance, as measured by the Mean Length of Utterances (MLU; Vermeulen et al., 1989; Thompson et al., 1995; Rossi & Bastiaanse, 2008). A close scrutiny of the structural qualities of the samples reveals two prominent features: the production of large proportions of ungrammatical sentences, and the limited use of embeddings (Bastiaanse, Hugen, Kos, & van Zonneveld, 2002; Saffran et al., 1989). For fluent aphasic speakers it has been documented that they have a reduced utterance length as well, due to many incomplete sentences. They also produce fewer embeddings than healthy speakers (Goodglass, Christiansen, & Gallagher, 1993; Bastiaanse, Edwards & Kiss, 1996; Edwards & Bastiaanse, 1998).

1.1.2. *Performance pattern at the word level in fluent and nonfluent aphasias*

1.1.2.1. Verb retrieval. At the word level, it has been reported that nonfluent aphasic speakers produce nouns and open class words in general to a normal extent (Berndt, Mitchum, Haendiges, & Sandson, 1997). This constitutes the most generally accepted difference with respect to fluent individuals (including those diagnosed with Wernicke's, Transcortical Sensory, Conduction, and Anomic aphasias). Edwards and Bastiaanse (1998) showed that both English and Dutch fluent aphasic speakers produce fewer nouns with a lower diversity than healthy speakers. However, a series of crosslinguistic studies have shown that, in the event of nonfluent deficits, the use of verbs is compromised in many languages, as shown by low diversity of the verbs that are produced by speakers with agrammatism (Dutch: Bastiaanse & Jonkers, 1998; Italian: Miceli et al., 1989; Swahili and English: Abuom & Bastiaanse, 2012; Turkish: Arslan, Bamyacı & Bastiaanse, 2016; for an overview in other languages the reader is referred to the sourcebook for agrammatism of Menn & Obler, 1990). However, Lorch (1990) found that the production of verbs was spared in some of the individuals included in her cross-linguistic study of Hindi, Icelandic and Finnish, but little variability across types was observed. In agrammatic spontaneous speech, there are also reports of a normal use of verbs in Indonesian, a language without verb inflection (Anjarningsih & Bastiaanse, 2011). There are only a few studies focused on the use of verbs in fluent aphasia, and these present a less clear pattern. Edwards and Bastiaanse (1998) show that some fluent speakers have problems retrieving verbs, whereas others display a normal pattern of performance. The same variation was shown by Bird and Franklin (1996). We will come back to this below.

Regarding complex and periphrastic verbal forms, nonfluent individuals have been found to experience problems with auxiliaries, which tend to be omitted, similar to copulas (Goodglass et al., 1993; Jonkers, 1993; Lapointe, 1985; Saffran et al., 1989; Vermeulen & Bastiaanse, 1984). In the case of fluent deficits, the literature includes contradictory results. While Jonkers (1993) reports no asymmetries between individuals with anomia and NBDs (non-brain-damaged participants), Vermeulen and Bastiaanse (1984) found that the former produced more auxiliaries than the latter. Goodglass et al. (1993) also found asymmetries between fluent and nonfluent individuals: fluent aphasic speakers showed a tendency to substitute auxiliaries, generally omitted in agrammatic speech.

1.1.2.2. Verb argument structure. A clear preference for utterances containing verbs with fewer internal arguments than in control counterparts has also been documented for nonfluent individuals (Bastiaanse & Jonkers, 1998; Byng & Black, 1989; Rossi & Bastiaanse, 2008; Thompson, Lange, Schneider, & Shapiro, 1997). The only study that took verb argument structure into account in fluent aphasic speech is the one of Edwards and Bastiaanse (1998). They found no difference between fluent aphasic and healthy speakers on the number of realized arguments.

1.1.3. Performance pattern at the inflectional level in fluent and nonfluent aphasias

At the morphological level, problems with verb inflection are frequently attested in the speech output of nonfluent individuals: the proportion of inflected verbs is generally low (Miceli, Mazzucchi, Menn, & Goodglass, 1983; Saffran et al., 1989; Thompson et al., 1995). Finiteness omissions coexist with normal or close to normal results for infinitives, participles or gerunds (Abuom & Bastiaanse, 2012; Bastiaanse et al., 2002; Lapointe, 1985). In the case of fluent individuals, substitutions affecting both verbs and verb inflection have been found to be more recurrent than in nonfluent individuals (Goodglass et al., 1993). Bastiaanse (2011) showed that fluent aphasic speakers produce normal proportions of finite verbs. However, when the lexical retrieval abilities of nonfluent agrammatic and fluent aphasic speakers are compared, an interesting phenomenon pops up.

Bastiaanse and Jonkers (1998) found that the diversity of verbs was diminished in agrammatic spontaneous speech, as was the proportion of finite verbs. When the individual patterns were compared, the following pattern was observed: some of the agrammatic speakers had a relatively normal diversity of verbs, but their proportion of finite verbs was lower than normal, whereas the opposite pattern was seen in other participants: low diversity of verbs with relatively high proportion of finite verbs. The authors argued that apparently there is a trade-off between verb retrieval and verb inflection for tense and agreement. If the agrammatic speaker focuses on verb retrieval, this is at the cost of verb inflection and the other way around. In a later analysis of agrammatic spontaneous speech, Bastiaanse et al. (2002) studied the use of verbs more in depth. They demonstrated that the diversity of lexical verbs was only lower for the finite verbs, not for the non-finite ones (infinitives, participles), and concluded that the interaction between verb retrieval and verb inflection was only true for finite verbs.

This interaction between verb retrieval and inflectional abilities has, surprisingly, also been observed in fluent aphasia (Bastiaanse, Jonkers, & Moltmaker-Osinga, 1995). These individuals are supposed to suffer from a lexical retrieval disorder, whereas grammatical abilities are assumed to be more or less intact. The diversity of verbs is lower than normal in fluent aphasia; however, this is only the case for finite verbs. The diversity is normal for the non-finite verbs (infinitives and participles). The word retrieval deficits in fluent aphasia are dependent on word frequency, in that high frequency words are easier to retrieve than low frequency words (e.g., Nickels & Howard, 1994). The finite verbs of fluent aphasic speakers do not only have a lower diversity, they also have a higher frequency than normal (and than the non-finite verb forms used by the same speakers). Again, this shows that there is an interaction between verb retrieval and verb inflection: if the verbs have to be inflected for tense and agreement, they are harder to realize than when they are non-finite, regardless of the aphasia type.

In sum, nonfluent and fluent aphasia sound entirely different: in nonfluent aphasia, compared to non-impaired speech, the speech rate is seriously diminished, the sentences are considerably shorter and simplified and many verbs are not inflected for tense and agreement. Fluent speech has a normal speech rate and intonation, sentences are shorter because they are broken off and there are word finding problems, as demonstrated by low diversity of verbs and nouns. The proportion of finite verbs is normal. However, a concise analysis shows that there are many similarities as well: verb production is impaired, but this impairment seems to be limited to finite verbs, suggesting an interaction between verb retrieval and verb finiteness. This interaction has been shown for Dutch and, to a certain extent, also for English. The current study focuses on the sentence and verb level in Spanish nonfluent and fluent aphasia.

1.2. Sentences and verbs in Spanish

Spanish is a Romance language spoken by more than 518 million people throughout the world, and constitutes the third most widely spoken language after Mandarin Chinese and English (Ethnologue, 2015). In Spain, Spanish is spoken by approximately 47 million people of whom 40% are bilingual in one of the other 4 official languages (Aranés, Basque, Catalan/Valencian and Galician; Stewart, 1999).

Spanish spoken in the Iberian Peninsula is primarily a SVO language, although variation in the order of constituents is commonly attested. In intransitive sentences, the order subject-verb (SV) vs. verb-subject (VS) is determined by two factors: lexical verb class (unergatives (1), which behave like transitives (2), or unaccusatives (3)) and information structure (with informationally focused elements appearing in sentence-final position (3b), contrary to English, where informational focus is realized phonologically, by stressing the focused element in-situ). The interaction of these factors is subtle, and unpredicted word orders do not lead to ungrammaticality, but to pragmatic anomalies.

(1) Carlos llora. (unergative)
    C. cries
(2) Carlos encontró un libro. (transitive)
    C. found a book
(3) a. El sol brilla. (unaccusative)
    b. Brilla el sol.
       The sun shines

Regarding verbs, Spanish is relatively synthetic and presents a moderate degree of inflection. In contrast to languages such as English, where bare roots are lexically well-formed words (*to work – I work*), Spanish is a [-zero] morphology language, i.e., roots are morphologically dependent units, and bare forms are not admitted (4).

(4) a. Cant -a- r
Sing -Iconj- Inf
b. Yo cant -a- ba
I sing -Iconj-imperfect.indicative.1st.sg

A thematic vowel is placed immediately after the verb root under certain circumstances and marks verb class. Spanish verbs can be classified according to the inflection they pertain to, depending on the thematic vowel they include (I -*a*-, II -*e*- or III -*i*-). Inflection is related to regularity, being members of class I the most frequent and regular verbs, and it has an impact on the temporal suffixes of a verb (5).

(5) a. *Amar* 'to love': Class I.
Marta amaba a los perros.
M. love-imperfect.indicative.3rd.sg dogs.
b. *Temer* 'to fear': Class II.
Marta temía a los perros.
M. fear-imperfect.indicative.3rd.sg dogs.

The verbal system includes 16 complete forms (10 tenses in the indicative paradigm + 6 tenses in subjunctive paradigm), in addition to the imperative. Out of the 16 tenses, 8 are simple and 8 are compound forms. Simple finite verbs are created from the verbal root and the thematic vowel followed by tense (past, present, future)/mood (indicative, subjunctive, imperative) and person (1st, 2nd, 3rd)/number (singular, plural) markers. Aspect (perfective, imperfective) is only distinguished in the past tense (preterit vs. imperfect), as in example (5) above. Compound forms are built up with the auxiliary verb *haber* 'to have' + the past participle of the main verb (6). Non-finite forms include the infinitive, the gerund and the past participle. Transitive verbs have both active and passive forms, built with the verb *ser* 'to be' + the past participle of main verb + an optional *by* phrase (7).

(6) Hoy he comido marisco.
Today (I) have-pres.3rd.sg eaten-pp seafood.
(7) El apartamento fue vendido por los herederos.
The apartment be.pret.3rd.sg sold-pp by the heirs.

In Spanish there are still other ways to refer to the present, the past or the future, by using periphrastic verbal constructions (8):

(8) a. *Present progressive* (*estar* 'to be'+ gerund):
Estoy comiendo.
(I) am eating
b. *Future referring periphrases* (ir a 'to go to' + infinitive):
Voy a comer.
(I) am going to eat.

Additionally, the time frame in which an event takes place can also be expressed by means of temporal lexical adverbs (*yesterday, now, soon*) and lexical adverbial phrases (*sometime ago* or *in a moment*), which require time reference agreement with the verb. Mismatches lead to ungrammaticality (9):

(9) *Ayer Juan juega al tenis.
*Yesterday J. plays tennis.

2. Methods

To investigate the efficacy of the analysis of spontaneous speech at the sentence and word level to pinpoint deficits in individuals with transcortical and mixed aphasias, we interviewed Spanish speaking individuals with and without aphasia and examined grammatical aspects of sentential measurements, including number of utterances, MLU, grammaticality, finiteness, and number of embeddings, and the use of verbs, focusing on lexical forms.

2.1. Participants

Semi-spontaneous speech samples of 25 Spanish-speaking participants, including adult individuals with fluent and nonfluent chronic aphasias of varied etiology (n = 10) and individuals without brain damage (n = 15), were analyzed. The decision was made to focus on those syndromes rarely addressed in the literature, including mixed and transcortical aphasias, to provide a detailed characterization of connected discourse in this group. Following standard practice, the performance of these participants was contrasted to that of healthy controls to capture significant differences. The outcomes of this research were compared to previous findings from individuals (mostly) with Broca's, Wernicke's and anomic aphasia widely described in the literature and summarized above.

The participants with aphasia included in this study were taken from the Rosell-Clarí (2005) corpus and comprised 7 individuals classified as nonfluent and 3 individuals classified as fluent; 5 were classified as mild and 5 as moderately impaired. Recruitment took place at the neurology service of the hospital Dr. Peset in Valencia. Consequently, most participants were bilingual (Spanish and Valencian), but all of them chose Spanish as their first language. Ages of patients, 7 men and 3 women, ranged from 46 to 82 years (mean age: 64.2), and they had varied educational and professional backgrounds. Etiologically, all 10 participants suffered a CVA in the left hemisphere and loss of their communication skills, as confirmed by their results in the Spanish adaptation of the Boston test (BDAE, Goodglass & Kaplan, 1972; 1983), and presented normal or corrected to normal vision and hearing. At the time of testing, they were all in neurologically stable condition (time post-onset > 1 year). All individuals had a medium level of comprehension above 60% in the auditory comprehension subtests of the BDAE. A summary of background information has been included in Table 1. Individual details are included as appendix A, Tables A1 and A2.

In addition to the participants with aphasia, 15 adults without brain damage (9 male and 6 female), ranging from 47 to 68 years of age (mean age: 58), were also included. These showed comparable characteristics as for age, gender, native language and degree of bilingualism, and professional and educational background.

2.2. Procedure

We analyzed the written transcripts of spontaneous speech obtained in semi-standardized interviews evoking past, present, and future events (Rosell-Clarí, 2005). The interviews included open questions (last job, holidays, and hobbies) of varying duration (20–30 min for the aphasia group, and 5–10 min for the NBD group). In the aphasia group, samples were recorded in 2–3 sessions, depending on the characteristics of each participant. Both the quantitative and the qualitative analyses were conducted over a subset of 300 words per participant, which is a reliable quantity (Nicholas & Brookshire, 1993; Vermeulen et al., 1989).

2.3. Analysis

The following criteria, taken from Vermeulen et al. (1989), were applied for the selection of the 300 word samples and the subsequent analysis. First, yes/no responses were left out of the word count, unless they were the only response given by the participants. Likewise, at least 60% of a word had to be produced in a recognizable fashion in order to be included. To calculate the MLU, when possible, sentence boundaries were established according to syntactic factors (and always before *and*), otherwise, noted pauses were used for segmentation (10). For utterance length, repetitions were omitted (following Vermeulen et al., 1989).

(10) ... y luego primero y segundo de bachillerato//bachillerato puede ser el letras y ciencias//esas son las dos opciones// tenemos eh bachipe [paraphasia]//eh el de ciencias//está el bachillerato tecnológico//el bachillerato &e que es//<no sé> &n no se te decir los nombres//

Table 1
Summary of participants.

	Age	Gender	Etiology	Severity
Nonfluent	64.3	4 males	1 Motor	3 mild
(n = 7)	(46–82)		2 Transcortical motor	4 moderate
			2 Mixed predominantly motor	
			2 Mixed predominantly motor with signs of transcorticality	
Fluent	64	3 males	3 Mixed aphasia predominantly anomic	2 mild
(n = 3)	(53–71)			1 moderate
NBDs	58	9 males		
(n = 15)	(47–68)			

... and then first and second of baccalaureate // baccalaureate can be the arts and sciences // these are the two options // [we] have eh baccalau [paraphasia] // eh the [one] of sciences // [there] is the technologic baccalaureate // the baccalaureate &e that is // <[I do] not know> &n [I do] not know you say the names //

(Speech sample JHC - Rosell-Clarí, 2005: 660)

After the sample selection and evaluation, data analysis proceeded in two stages. First, the 300 word samples were segmented into utterances for the calculation of the number of utterances, mean length of the utterances (MLU), percentage of grammatical utterances, percentage of finite clauses, and percentage of embedded clauses. After this first analysis, verbs were extracted and classified into different categories: lexical, copulas, and modals & aspectuals (11a-c).

(11) a. *Lexical verbs:*
El niño corre.
The boy run-present.indicative.3rd.sg.
b. *Copulas:*
(Él/ella) es/está aburrido.
(S/he) be.present.indicative.3rd.sg bored
(S/he) is boring/bored.
c. *Modals & Aspectuals:*
Pude salir.
I could go out.

Lexical verbs were further analyzed. The distribution of finite and non-finite forms and the type/token ratio of these forms was calculated. Lexical verbs were also classified according to their argument structure: unergatives, transitives, and unaccusatives. Two additional factors, aphasia group (fluent, nonfluent) and severity (mild, moderate), were included in the data analysis.

To verify the reliability of the method of analysis, the samples were analyzed by two independent, experienced raters. Conflictive cases were noted, and final decisions were made by consensus. Since the group scores were not normally distributed, Kruskal–Wallis and Mann-Whitney-U tests were used for statistical measurements across groups. Friedman test and Wilcoxon signed-rank test were also run for related samples. These were run using SPSS 20.0. Based on Crawford and Howell (1998) and Crawford and Garthwaite (2002), the significance of the individual performance of participants with aphasia was also compared to the mean score of the healthy participants.

3. Results

3.1. Performance at the sentence level

The results of the first analysis are summarized in Table 2. Nonfluent individuals produced a mean of 51.5 utterances (vs. 29.4 for NBDs). The ratio decreases in the fluent group (mean: 47.3). Differences in the number of utterances per group reached significance in the statistical analysis (Kruskal Wallis: $\chi 2$ $(2, N = 25) = 16.149$, $p = 0.000$). Additional post-hoc tests further confirmed differences between NBDs and nonfluent individuals (MannWhitney U Tests: $U = 0.5$; $Z = -3.470$, $p = 0.001$), and between NBDs and fluent individuals (MannWhitney U Tests: $U = 2.5$; $Z = -2.755$, $p = 0.006$). Consequently, the MLU shows the inverse pattern. There was a decreased number of words per utterance related to group: NBDs > Fluent > Nonfluent (Kruskal Wallis: $\chi 2$ $(2, N = 25) = 17.184$, $p = 0.000$). Further testing with MannWhitney U tests revealed that differences held both between NBDs and nonfluent individuals ($U = 0$; $Z = -3.503$, $p = 0.000$), and between NBDs and fluent individuals ($U = 1$; $Z = -2.900$, $p = 0.004$). Due to the reduced number of participants in the fluent group, differences between the nonfluent and the fluent participants did not reach significance for the MLU or for the number of utterances. Significant differences were confirmed at the individual level for all the participants in the nonfluent group for the total number of utterances and the MLU. Variation was found in the performance of the fluent participants. Differences in the

Table 2
Results of the grammatical analysis (MLU = mean length of utterances, NBD = non brain-damaged speakers).

Group	NBDs (n = 15)	Fluent (n = 3)	NonFluent (n = 7)
Utterances	29.4	47.3	51.5
MLU	10.2	6	5
% Grammatical clauses	97.7%	73.3%	43.8%
% Finite clauses	85.5%	72.3%	63.2%
% Embeddings	39.4%	34.2%	21.0%

number of utterances reached significance in 2 out of the 3 participants (S04: t = 4.520, p = 0.000; S06: t = 1.890, p = 0.040). But only in 1 of the fluent participants the analysis of the MLU reached significance (S04: t = −2.445, p = 0.014), while for a second one, differences were marginally significant (S06: t = −1.645, p = 0.061). Individual results are plotted in Appendix B.

The pattern for grammaticality and finiteness is similar to what was observed for the MLU (NBDs > Fluent > Nonfluent). NBDs produced higher percentages of grammatical utterances containing finite verbs (97.7% grammatical utterances, out of which 85.5% are finite) than individuals with fluent deficits (73.3% grammatical, 72.3% finite). As expected, individuals in the nonfluent group experienced more difficulties both in the production of grammatical structures (43.8% correct), and in the inclusion of finite verb forms in their output (63.2% finite). Across groups, Kruskal Wallis tests showed significant differences for the two variables (Grammaticality: $\chi 2$ (2, N = 25) = 18.661, p = 0.000; Finiteness: $\chi 2$ (2, N = 25) = 12.495, p = 0.002). For grammaticality, the output of NBDs was found to differ significantly from both nonfluent and fluent individuals in MannWhitney U Tests (Nonfluent group: U = 0; Z = −3.648, p = 0.000; Fluent group: U = 0; Z = −3.172, p = 0.002). The significance tests run at the individual level confirmed these differences for all nonfluent and fluent participants (see Appendix B). However, for finiteness, differences were found to be significant only for the contrast NBDs vs. nonfluent participants (Mann Whitney *U* test: U = 0; Z = −3.590, p = 0.000). At the individual level, the performance of all participants in the nonfluent group reached significance with only one exception (S10: t = 0.157, p = 0.439). No differences were found between NBDs and fluent participants (Mann Whitney *U* test: U = 15.5; Z = −1.454, p = 0.152), although this may be due to the behavior of S02. Individual results are included in appendix B. Again, the comparison between the nonfluent and in the fluent group did not reach significance.

Differences across groups were also attested as for the use of embedded constructions (NBDs > Fluent > Nonfluent). The speech outputs of the 3 groups differed significantly at this respect (Kruskal Wallis: (2, N = 25) = 7.865, p = 0.020). Later post hoc analysis indicated that differences only held between NBDs and the participants in the nonfluent group (Mann Whitney *U* test: U = 9; Z = −2.803, p = 0.005). However, a latter analysis at the individual level revealed that these differences are restricted to the performance of 3 individuals (S03: t = −2.193, p = 0.023; S08: t = −2.841, p = 0.007; S09: t = −2.609, p = 0.010). In the fluent group, only 1 participant was found to differ significantly from the mean score of NBDs (S04: t = −2.105, p = 0.027). A summary of the results of the grammatical analysis at the sentence level is displayed in Fig. 1.

3.2. Performance at the word and inflectional levels

The next step in our analysis had to do with the classification of verbal forms. The results are captured in Table 3. Although, on average, fluent speakers produce more verbal forms than the NBDs and the nonfluent participants (NBDs = 54.8, 16.7%; Fluent = 63, 21%; Nonfluent = 53.3, 17.8%), no significant differences in the total number of verbs were found in the group analysis when lexical and functional verbs (grammatical and ungrammatically produced) were analyzed together (Kruskal Wallis: Nº verbs - $\chi 2$ (2, N = 25) = 1.684, p = 0.431; Type/token ratio - $\chi 2$ (2, N = 25) = 4.469, p = 0.107). Individual statistical measurements have been included in Appendices C and D.

Next, verbs were further classified into different categories: lexical verbs, copulas, and modals and aspectuals. As shown in Table 3, all three groups of participants produced a higher percentage of lexical verbs, followed by copulas and modals and aspectuals. A Friedman test confirmed that differences across types of verbs were significant for nonfluent and control individuals ($\chi 2(2)$ = 12.074, p = 0.002 and $\chi 2(2)$ = 27.763, p = 0.000, respectively), but not for the participants in the fluent group ($\chi 2(2)$ = 4.667, p = 0.097). Post hoc analysis with Wilcoxon signed-rank tests revealed differences for all three

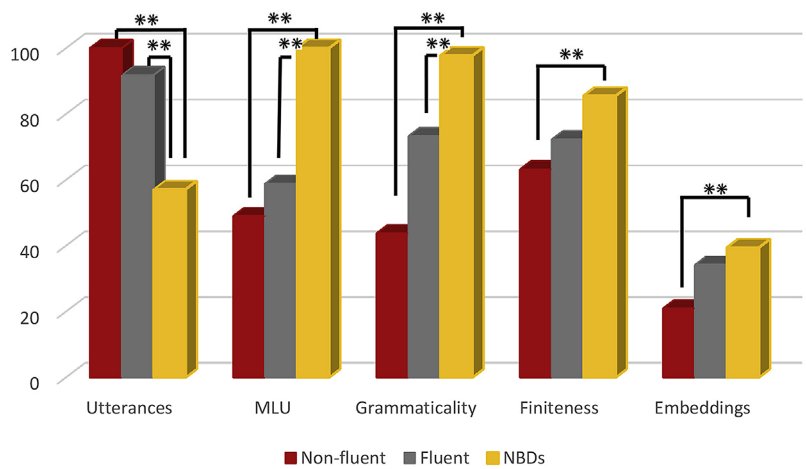

Fig. 1. Preliminary summary of findings (utterances, MLU, grammaticality, finiteness and embeddings).

Table 3
Results of the analysis of verbs (TTR = type/token ratio, NBD = non brain-damaged speakers).

Group	NBDs (n = 15)	Fluent (n = 3)	NonFluent (n = 7)
Total verbs	54.8	63	53.3
TTR (all verbs)	0.44	0.34	0.44
% Lexical verbs	67%	59.3%	61.1%
TTR (lexical verbs)	0.54	0.45	0.59
TTR (lexical finite)	0.56	0.54	0.59
TTR (lexical non-finite)	0.75	0.57	0.84
% Copulas	22.1%	22.2%	21.5%
% Modals and aspectuals	10.8%	18.5%	17.4%

comparisons, with the exception of copulas vs. modals and aspectuals in the nonfluent group: a) lexical – copulas (nonfluent: $Z = -2.366$, $p = 0.018$, NBDs: $Z = -3.409$, $p = 0.001$), b) lexical – modals and aspectuals (nonfluent: $Z = -2.366$, $p = 0.018$, NBDs: $Z = -3.411$, $p = 0.001$), and c) copulas –modals and aspectuals (NBDs: $Z = -2.862$, $p = 0.004$).

Across groups, differences in the total number of occurrences only reached significance for the group of modals and aspectuals (Kruskal Wallis: $\chi 2$ (2, N = 25) = 7.316, $p = 0.026$). Later post-hoc tests showed that these differences were restricted to the contrast between NBDs and fluent participants (Mann Whitney *U* test: U = 4; $Z = -2.209$, $p = 0.027$). Moreover, the individual analysis revealed that this may be due to the results of a single participant (S02: $t = 2.323$, $p = 0.018$). Lack of differences may be attributed to the wide variation across individuals, also found in the group of NBDs (mean = 5.93, SD = 3.79) (see Appendix C for a detailed list of individual results across different verb types). Fig. 2 summarizes group differences in the distribution of verb forms across types.

As for the type/token ratio of lexical verbs (Mean Type/Token ratio: 0.52 aphasia groups vs. 0.54 controls), no differences were found in the statistical analysis (Kruskal Wallis: Type/token ratio - $\chi 2$ (2, N = 25) = 2.997, $p = 0.224$). However, the mean was found to be higher in individuals with nonfluent aphasias than in those with fluent aphasias (Mean Type/Token ratio lexical verbs: 0.59 and 0.45 respectively). The significance of individual performances is summarized in Appendix D.

Following Bastiaanse and Jonkers (1998), we explored a possible trade-off between finiteness and diversity in the samples of the participants with aphasia (PWAs). The individual results are captured in Fig. 3:

According to Bastiaanse and Jonkers (1998), reduced processing resources would justify asymmetries across these two variables, with low diversity of verbs resulting in a relatively high proportion of finite verbs, and high diversity of verbs resulting in a relatively low proportion of finite verbs in participants with agrammatic aphasia, while above mean performance is expected in fluent participants. Indeed, the trade-off between diversity and finiteness would account for the performance of 5 out of the 7 individuals in our nonfluent sample (S01, S05, S08, S09, S10), but, as in Bastiaanse and Jonkers's (1998) study, not for the performance of the individuals in the fluent group, who scored above mean for both diversity and finiteness (S02, S04, S06).

On average, the NBDs were the only participants who produced significantly more finite than non-finite verbs (mean: 24.6 finite, 12.07 non-finite; $Z = -3.327$, $p = 0.001$). The analysis of the type/token ratio showed no differences for finite forms and higher diversity rates for non-finite forms in the NBD group ($Z = -3.010$, $p = 0.003$), and, marginally, in the group of nonfluent participants ($Z = -1.863$, $p = 0.063$). Across groups, although the distribution of the number of finite and non-finite forms was the same across groups, the Kruskal Wallis tests showed marginal significant differences in the type/token ratio for non-finite

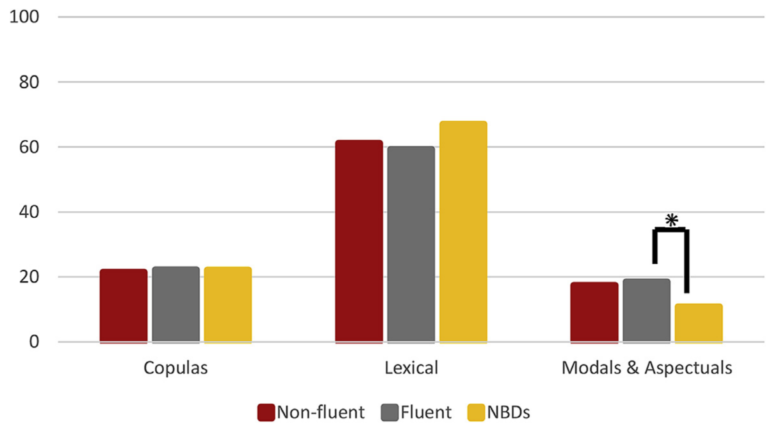

Fig. 2. Distribution of verbs across groups.

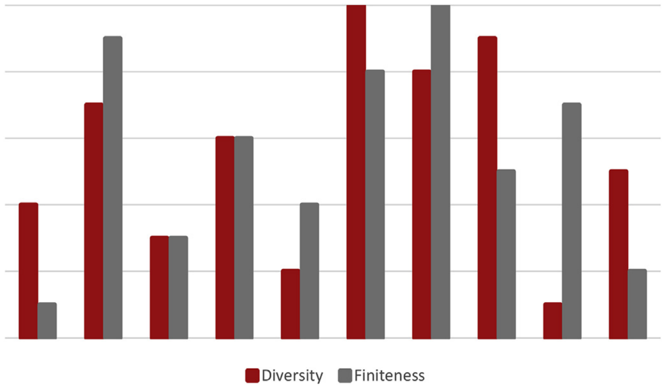

Fig. 3. Interaction between finiteness and diversity in PWAs.

lexical forms ($\chi2$ (2, N = 25) = 5.687, p = 0.058). Post hoc tests restricted the contrast to the comparison between nonfluent and fluent participants (Mann Whitney *U* test: U = 2; Z = −1.1961, p = 0.067). Individual results are included in appendix D.

Further differences between participants with and without aphasia were attested in the analysis of argument structure. Transitive verbs were produced more frequently than unergatives and unacussatives across the board. On average, 20.6 transitive forms were documented in the speech output of individuals with nonfluent deficits, 19.7 in the fluent group, and 21.9 in the NBD group (vs. 8.1, 15.7, and 8.5 occurrences of unergative verbs and 3.8, 2, and 6.3 occurrences of unaccusative verbs). A Friedman test showed that differences were significant for nonfluent and NBD participants alone ($\chi2(2)$ = 11.308, p = 0.004 and $\chi2(2)$ = 18.407, p = 0.000, respectively). Post hoc analysis with Wilcoxon signed-rank tests revealed differences for all three comparisons: a) transitive - unergative (nonfluent: Z = −2.201, p = 0.028, NBDs: Z = −3.325, p = 0.001), b) transitives - unaccusatives (nonfluent: Z = −2.371, p = 0.018, NBDs: Z = −3.353, p = 0.001), and c) unergatives - unaccusatives (nonfluent: Z = −1.997, p = 0.046, NBDs: Z = −1.925, p = 0.054).

Across groups, the statistical analysis revealed that PWAs only produced significantly less unaccusative forms than their NBD counterparts (Kruskal Wallis: Type/token ratio - $\chi2$ (2, N = 25) = 6.432, p = 0.040). Post hoc testing attested that, contrary to what has been widely documented in the literature, these differences were due to the abnormal behavior of the participants in the fluent group, who produced a significantly lower number of these forms (Mann Whitney *U* test: U = 3.5; Z = −2.271, p = 0.023). However, due to the low number of unaccusative verbs in the aphasia samples and the variability of the performance of the control individuals (mean: 6.33, SD: 3.48), these differences do not reflect in the individual significance tests (see Appendix E).

In addition to the differences in the total number of produced forms, while PWAs mostly adjusted to the following pattern: transitives ≥ unergatives ≥ unaccusatives (Fig. 4), there is considerable individual variation among the 15 participants in the NBD group (Fig. 5), with participants such as 13, producing more unaccusatives than transitives or unergatives.

3.3. *Performance at the sentence, word and inflectional according to degree of severity*

So far, we have focused on the contrast between individuals with and without brain damaged, and fluent and nonfluent PWAs. In what follows we summarize the results according to the degree of severity of the aphasic deficit. As mentioned in section 2, our aphasia sample included 5 participants classified as mild and 5 classified as moderate. An exhaustive analysis of the results revealed that, at the sentence level, asymmetries across groups (mild vs. moderate) were restricted to the same variables as in the analysis based on the diagnose. A summary of the results of the Kruskal Wallis tests has been added in Table 4.

At the sentence level, further post-hoc testing confirmed differences for all the variables between NBDs and moderate individuals. Differences also hold for the contrast between NBDs and mild participants, with the exception of the presence of embeddings (Mann Whitney *U* test: U = 28; Z = -0.829, p = 0.445). Individuals with moderate aphasic deficits produced 18.56% utterances containing a subordinate structure (vs. 39.37% in NBDs). However, in the event of mild deficits percentages are close to those in the NBD sample (31.46% utterances contained a subordinate construction) (see Appendix F for the complete set of comparisons).

In the case of verbs, we also found differences as for the number of lexical verbs, copulas and modals and aspectuals both for mild (Friedman test: $\chi2(2)$ = 8.400, p = 0.015) and moderate participants (Friedman test: $\chi2(2)$ = 7.895, p = 0.019). Later post hoc analyses revealed that differences were restricted to the contrast between lexical forms and copulas (Wilcoxon signed-rank tests: mild - Z = −2.023, p = 0.043, moderate - Z = −2.023, p = 0.043), and lexical forms and modals & aspectuals (Wilcoxon signed-rank tests: mild - Z = −2.023, p = 0.043, moderate - Z = −2.023, p = 0.043). Differences were also found in the comparison of transitive, unergative and unaccusative forms (Friedman tests: mild - $\chi2(2)$ = 6.400, p = 0.041, moderate - $\chi2(2)$ = 7.444, p = 0.024). Later post hoc analyses revealed that differences were confined to the comparisons including

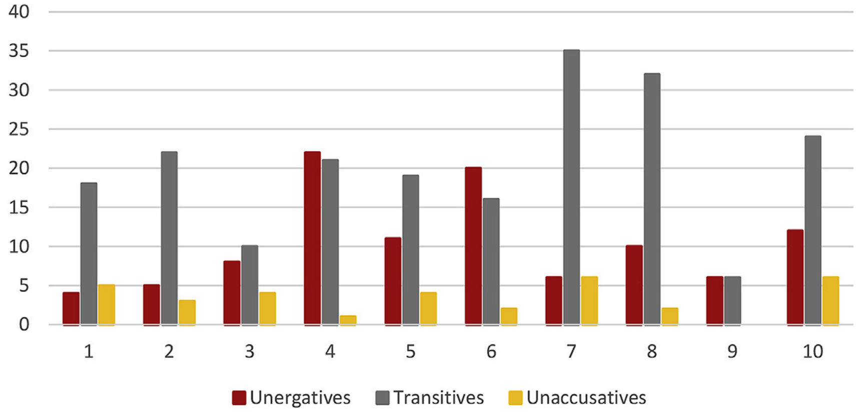

Fig. 4. Lexical verbs – aphasia group.

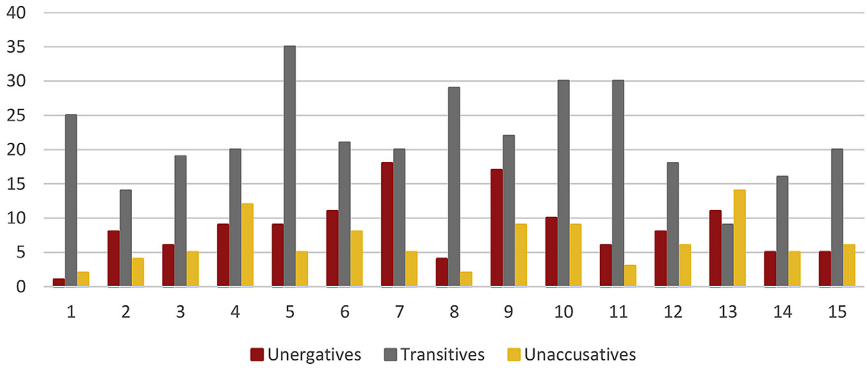

Fig. 5. Lexical verbs – NBD group.

Table 4
Significant differences in performance according to severity.

Statistical analysis	Results
MLU	$\chi 2$ (2, N = 25) = 17.211, p = 0.000
Nº of Utterances	$\chi 2$ (2, N = 25) = 16.125, p = 0.000
Grammaticality	$\chi 2$ (2, N = 25) = 18.240, p = 0.000
Finiteness	$\chi 2$ (2, N = 25) = 12.218, p = 0.002
Embeddings	$\chi 2$ (2, N = 25) = 7.820, p = 0.020
Modals & Aspectuals	$\chi 2$ (2, N = 25) = 5.790, p = 0.055
Unaccusatives	$\chi 2$ (2, N = 25) = 4.993, p = 0.082
Type/token (all verbs)	$\chi 2$ (2, N = 25) = 5.926, p = 0.052

unaccusative forms. Significantly less unaccusatives than transitive verbs were found both in mild and moderate participants (Wilcoxon signed-rank tests: mild - Z = −2.023, p = 0.043, moderate - Z = −2.032, p = 0.042). The comparison between unergatives and unaccusatives was marginally significant in the moderate group (Wilcoxon signed-rank test: Z = −1.826, p = 0.068).

Across groups, although differences in the use of modal and aspectual verbs hold, for unaccusative verbs, differences were no longer significant ($\chi 2$ (2, N = 25) = 4.993, p = 0.082). Further post-hoc testing confirmed that differences between NBDs and moderate individuals are only marginally significant for modals and aspectuals (Mann Whitney *U* test: U = 16; Z = −1.891, p = 0.066) and unaccusative verbs (Mann Whitney *U* test: U = 16.5; Z = −1.850, p = 0.066). Moderate participants experienced more difficulties with unaccusative verbs than their mild counterparts (2 and 3.8 forms on average respectively vs. 6.3 for NBDs), who did not differ significantly from NBDs (Mann Whitney *U* test: U = 19.5; Z = −1.593, p = 0.119) (see Appendix F for the complete set of comparisons).

Regarding the number of verbs and the type/token ratio, contrary to the analysis based on diagnose, the analysis according to degree of severity show marginal differences only for the type/token ratio when all verbs were analyzed together (Kruskal Wallis: Type/token ratio - $\chi 2$ (2, N = 25) = 5.926, p = 0.052), but these are to be attributed to the mild participants, since for moderate individuals differences are not significant (Mann Whitney *U* test: U = 33; Z = -0.393, p = 0.735). Additionally, no differences were found in the type/token ratio of lexical verbs alone (Kruskal Wallis: $\chi 2$ (2, N = 25) = 2.869, p = 0.238). When finite and non-finite forms are analyzed separately, mild individuals were found to produce significantly more finite verbs (Z = −2.023, p = 0.043). However, no differences in the type/token ratio were found for either finite or non-finite verbs in the across group comparison (Kruskal Wallis: $\chi 2$ (2, N = 25) = 4.107, p = 0.128 and $\chi 2$ (2, N = 25) = 0.080, p = 0.961, respectively). Similar to what we have found when comparing fluent and nonfluent participants, no differences were found between mild and moderate participants, except for the marginal differences in the token/type ratio of all verbs (Mann Whitney *U* test: U = 3.5; Z = −1.886, p = 0.056).

4. Discussion

In line with previous analyses of spontaneous speech, we have examined the problems that speakers with aphasia encounter across three main levels (the sentence, the word and the inflectional level) to evaluate which are the most revealing measurements in cases of mild and moderate mixed aphasias in Spanish. Our results highlight the relevance of spontaneous speech for the characterization of the less investigated mixed cases of aphasia, which share characteristics from fluent and non-fluent deficits, and confirm and receive support from previous cross-linguistic findings obtained through similar methodological approaches and through experimental tasks.

4.1. Performance at the sentence level

Individuals without brain damage display a significantly higher MLU (and a lower number of utterances) than individuals in the aphasia group (with fluent individuals scoring higher than their nonfluent counterparts), despite the wide variability observed across participants in the latter. This is consistent with Sahraoui and Nespoulous's (2012) findings for French. The spontaneous speech of nonfluent individuals display a form of discourse compensation strategy: extended discourse (shorter but more numerous utterances) with reduced syntax.[1]

In agreement with the cross-linguistic literature, lower grammaticality, finiteness and subordination indices were also found in the nonfluent group. In all cases, differences with respect to NBDs reached significance in the statistical tests. The pattern of performance of individuals in the nonfluent group is especially remarkable if we consider their results for finiteness in contrast with those for the total number of utterances, that is, the number of contexts a priori suitable of containing (at least) one finite verb. Despite producing more sentences than any other group (mean: 51.5 utterances vs. 29.4 for NBDs), this didn't translate into the use of more inflected verbal forms. On the contrary, their deficit counteracted this effect. The participants in the fluent group also differed from NBDs as for the grammaticality index. However, no differences were found as for the percentage of finite utterances or embedded constructions they produce. With respect to the severity of the individual deficits, both mild and moderate individuals experienced difficulties with all the above mentioned variables except for the production of embedded structures, which only differed from normals in the case of moderate participants. However, it is important to note that, contrary to standard practice, in our analysis, both grammatical and ungrammatical attempts have been annotated. Taken together, these results validate the accuracy of measures at the sentence level to predict the performance of individuals with aphasia independent of diagnose and degree of severity.

4.2. Performance at the word and inflectional levels

Regarding verbs, taken all together, no significant differences were found as for the number of verbs per group, and these were only marginal when taking into account degree of severity. When further classified according to their function and argument structure, modals and aspectuals were found to be more frequent in the speech of fluent PWAs, while lexical verbs and copulas show a normal distribution. Although this difference may be mostly attributed to the performance of a single subject, marginal differences were also found when comparing mild and moderate participants to controls. Asymmetries were not detected in the type/token ratio when all verbs were analyzed together, or when lexical verbs were isolated. However, as in Bastiaanse and Jonkers (1998), the interaction between diversity and finiteness can predict the performance of participants in the nonfluent group with higher diversity resulting into lower finiteness indexes and vice-versa. Contrary to Bastiaanse (2011), differences arise when both finite and non-finite verbs are analyzed together. Although, our fluent participants were also found to exhibit a lower diversity than controls, this was the case with independence of finiteness. However, it is important to note that the fluent participants in our study have mixed deficits (with anomic predominance), while those in Bastiaanse's (2011) study were diagnosed as Wernicke's or anomic.

Further deficits were found with lexical verbal entries with a more complex thematic grid, more specifically unaccusative verbs (vs. unergatives and transitives, which display a normal distribution). These findings go in line with previous results from structured tasks, including naming, sentence completion and forced choice in nonfluent populations (Martínez-Ferreiro, Bachrach, Sánchez Alonso, & Picallo, 2014; Sánchez-Alonso, Martínez-Ferreiro, & Bastiaanse, 2011). However, in this case, it is

[1] We thank one of the reviewers for the comments on this issue.

the fluent group the one experiencing the more severe difficulties with this group of verbs. When severity is taken as the grouping variable, differences only hold for the group of moderate participants.

The results obtained for unaccusative entries can be explained in terms of two influential hypotheses, the Argument structure complexity hypothesis (ASCH; Thompson, 2003) and the Derived order problem hypothesis (DOP-H; Bastiaanse & van Zonneveld, 2005; Dragoy & Bastiaanse, 2010), originally proposed to account for the results of individuals with nonfluent aphasias. According to the ASCH, verbs that entail a more complex argument structure are more difficult to produce. Complexity is defined as the number of arguments and the type of argument structure information (Thompson, 2003). According to the DOP-H, movement operations leading to a change in the base generated position of constituents complicate production (Bastiaanse & van Zonneveld, 2005; Dragoy & Bastiaanse, 2010). Our results indicate that this is the case in non-prototypical aphasia cases. Differences with respect to NBDs were only detected in the production of unaccusative verbs (vs. unergatives and transitives), which were less frequently attested in the speech output of PWAs. This suggests that the ASCH and the DOP-H can predict the outcomes of both nonfluent and fluent individuals in so far they consider individual variation.

Taken together, the results of verbs show that, contrary to the indices at the sentence level, at the inflectional, and more remarkably at the word level, the participants in this study display a wide range of variation. This coincides, as noted in the introduction, with the results discussed in the previously existing literature, which is not short of controversy as for the expected pattern of performance, especially in fluent cases.

Across participants, the studied performance patterns seem to indicate that measures at the sentence level, to the inclusion of argument structure, are more reliable for a better assessment and diagnosis of fluent and non-fluent deficits, since they have been found to be more consistent across participants. At the individual level, one of the main strengths of the analysis of spontaneous speech data is that it also allows for the in-depth exploration of microstructural aspects of connected discourse in individual cases, which can be exploited in therapeutic settings. Additionally, in agreement with Dronkers (2000), our sample provides further evidence for the abandonment of the traditional brain-language relationship based on Broca's area, Wernicke's area, and the arcuate fasciculus as the key structures involved in language in favor of a complex network. Informants in the aphasia group have lesions affecting all four lobes and also certain subcortical structures (basal ganglia, corona radiata) and still the linguistic profiles are similar for some of the participants (e.g. JHC and VMH with a posterior parietal lesion and a lesion in the corona radiate respectively present the same diagnose, mixed aphasia of anomic predominance). Interestingly, the opposite scenario is also attested, similar lesions such as those of JPC and JHC, affecting the posterior parietal lobe, were found to give rise to two distinct outcomes (mixed aphasia of motor and anomic predominance respectively).[2]

So far, we are just scratching the surface. In this article, we have focused on the major indicators at the sentence level (MLU, number of utterances, grammaticality, finiteness and subordination), lexical verbs, and more specifically on argument structure. We have left behind considerations such as grammaticality (the analysis of correct responses alone) or the presence of obligatory arguments, not to mention tense, agreement or time reference, all issues to be resumed in future research. Additionally, we attributed the lack of statistical differences between the aphasia groups (fluent-nonfluent, mild-moderate), to the small number of participants. We expect that the inclusion of more samples will provide us with stronger arguments to highlight the importance of spontaneous speech observation in the assessment of (Spanish speaking) individuals with non-prototypical cases of aphasia of varying degree of severity.

5. Conclusion

In sum, in line with previous findings, individuals with mixed aphasias of motor predominance produced shorter and/or fragmentary utterances. Interestingly, this was also the case for mixed aphasias predominantly sensory, indicating asymmetries between NBDs and PWAs for these variables independent of diagnose. In the speech output of participants with aphasia, there was a larger proportion of ungrammatical sentences, and a reduction of finiteness observable in nonfluent participants. Although there were no differences in the total number of verbs, PWAs produced a lower proportion of unaccusative verbs across the board. Hence, our data serves as a window to argument structure deficits, and to the existence of problems with unaccusative verbs, which, again, are not restricted to individuals with a specific aphasia type or degree of severity. Further analyses and more statistical power would allow us to run parametric tests to reveal correlations between number of sentences, number of lexical verbs and type/token ratios, as well as exploring other observable deficits.

Acknowledgements

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[2] We thank one of the reviewers for the comments on this issue.

Appendix A. Demographic data

Table A1
Background information of participants.

Aphasia Group	Age	Gender	TPO	BDAE Auditory Comp.	NBD group	Age	Gender
JHG	40	M	2	92.01	1	64	M
JHC	71	M	2	87.5	2	63	F
ABL	46	M	1	84.17	3	54	M
VMH	53	M	4	65	4	55	M
JPC	65	M	2	61.18	5	54	F
BPL	68	M	3	71.18	6	68	M
CAR	82	F	2	61.87	7	57	M
CMG	72	F	7	72.71	8	57	F
JRA	75	M	4	77.15	9	64	F
TCP	60	F	6	86.73	10	52	M
					11	55	F
					12	60	M
					13	47	M
					14	60	F
					15	58	M

*TPO: Time post-onset (in years).

Table A2
Etiology, diagnose and severity of the participants with aphasia.

	Etiology	Aphasia type	Severity
JHG	Left ischemic Sylvian CVA, anterior subdivision. Arterial embolism, spontaneous dissection of the left internal carotid artery (segment C_1). Possible fibromuscular dysplasia.	Transcortical motor	Mild
JHC	Left ischemic Sylvian CVA, affecting the posterior parietal portion.	Mixed predominantly anomic	Mild
ABL	Ischemic CVA in the middle and left anterior cerebral artery, secondary to occlusion of the extracranial internal carotid artery, affecting the basal ganglia.	Motor	Moderate
VMH	Ischemic CVA in the left corona radiata with a thrombotic profile of hypertensive origin.	Mixed predominantly anomic	Moderate
JPC	Left posterior parietal ischemic CVA of embolic origin.	Mixed predominantly motor	Moderate
BPL	Ischemic infarction in left temporal lobe affecting the temporo-parieto-occipital region.	Mixed predominantly anomic	Mild
CAR	Left temporoparietal hematoma.	Mixed predominantly motor	Moderate
CMG	Multiple ischemic Sylvian stroke affecting the left corona radiata and the right Sylvia area, embolic.	Mixed predominantly motor with signs of transcorticality	Mild
JRA	Ischemic infarction in left frontal lobe.	Mixed predominantly motor with signs of transcorticality	Moderate
TCP	Left ischemic antero-Sylvian infarction, embolic.	Transcortical motor	Mild

Appendix B. Grammatical analysis − individual differences.

Group	Nº	Utterances	MLU	Grammaticality	Finiteness	Embeddings
Non Fluent	S01 (mild)	**t = 2.037, p = .031**	***t = −1.741, p = .052***	**t = −13.939, p = .000**	**t = −2.606, p = .010**	t = −0.424, p = .339
	S03 (moderate)	**t = 3.059, p = .004**	**t = −2.377, p = .016**	**t = −14.991, p = .000**	**t = −3.845, p = .001**	**t = −2.193, p = .023**
	S05 (moderate)	**t = 1.890, p = .040**	***t = −1.741, p = .052***	**t = −20.567, p = .000**	**t = −2.036, p = .031**	t = −0.544, p = .297
	S07 (moderate)	**t = 3.351, p = .002**	**t = −2.250, p = .021**	**t = −11.753, p = .000**	**t = −3.560, p = .002**	t = −0.888, p = .195
	S08 (mild)	**t = 6.712, p = .000**	**t = −2.887, p = .006**	**t = −16.060, p = .000**	**t = −6.408, p = .000**	**t = −2.841, p = .007**
	S09 (moderate)	**t = 2.037, p = .031**	**t = −2.547, p = .012**	**t = −29.682, p = .000**	**t = −9.398, p = .000**	**t = −2.609, p = .010**
	S10 (mild)	**t = 3.059, p = .004**	**t = −2.038, p = .030**	**t = −19.665, p = .000**	t = 0.157, p = .439	t = −0.800, p = .218
Fluent	S02 (mild)	t = 1.160, p = .133	t = −1.189, p = .127	**t = −6.210, p = .000**	t = −0.228, p = .412	t = 1.056, p = .154
	S04 (moderate)	**t = 4.520, p = 000**	**t = −2.445, p = .014**	**t = −7.245, p = .000**	**t = −4.087, p = .001**	**t = −2.105, p = .027**
	S06 (mild)	**t = 1.890, p = .040**	*t = −1.645, p = .61*	**t = −11.252, p = .000**	**t = −3.688, p = .001**	t = −0.176, p = .431

Bold indicates significant differences and italics indicate marginal differences.

Appendix C. Analysis of verbal forms – individual differences

Group	Nº	All verbs	Copulas	Lexical verbs	Mod. & Asp.
Non Fluent	S01 (mild)	t = 0.107, p = .458	*t = 1.642, p = .061*	t = −1.163, p = .132	t = 0.786, p = .222
	S03 (moderate)	t = −1.503, p = .077	t = −0.236, p = .409	**t = -1.761, p = .050**	t = −0.238, p = .480
	S05 (moderate)	t = −0.161, p = .437	t = −0.027, p = .489	t = −0.326, p = .374	t = 0.274, p = .394
	S07 (moderate)	**t = 2.255, p = .020**	t = −0.862, p = .202	t = 1.228, p = .120	**t = 4.885, p = .000**
	S08 (mild)	t = 0.018, p = .493	t = −1.279, p = .111	t = 0.869, p = .200	t = −0.238, p = .408
	S09 (moderate)	**t = −2.577, p = .011**	t = −1.070, p = .151	**t = −2.956, p = .005**	t = 0.274, p = .394
	S10 (mild)	t = 0.913, p = .188	t = 0.808, p = .216	t = 0.630, p = .269	t = 0.274, p = .394
Fluent	S02 (mild)	t = 1.450, p = .085	**t = 2.894, p = .006**	t = −0.804, p = 2.17	**t = 2.323, p = .018**
	S04 (moderate)	t = 0.644, p = .265	t = −0.862, p = .202	t = 0.869, p = .200	t = 1.043, p = .157
	S06 (mild)	t = 0.107, p = .458	t = −0.862, p = .202	t = 0.152, p = .441	t = 1.043, p = .157

Bold indicates significant differences and italics indicate marginal differences.

Appendix D. Analysis of type/token ratios – individual differences

Group	Nº	TTR all verbs	TTR Lexical verbs	TTR Lexical verbs Finite forms	TTR Lexical verbs Non-finite forms
Non Fluent	S01 (mild)	t = −0.899, p = .192	t = 0.108, p = .458	t = −0.807, p = .217	***t = 1.729, p = .053***
	S03 (moderate)	t = 0.470, p = .323	t = 1.076, p = .150	t = 0.000, p = .500	***t = 1.729, p = .053***
	S05 (moderate)	t = 0.705, p = .246	t = 1.506, p = .077	*t = -1.614, p = .064*	t = −0.553, p = .294
	S07 (moderate)	t = −0.899, p = .192	t = −0.968, p = .175	t = 0.323, p = .376	t = −1.522, p = .075
	S08 (mild)	t = −0.553, p = .294	t = −1.183, p = 128	t = −1.493, p = .079	t = 1.176, p = .130
	S09 (moderate)	**t = 1.895, p = .39**	**t = 4.080, p = .001**	**t = 2.421, p = .015**	**t = 1.729, p = .053**
	S10 (mild)	t = −0.761, p = .230	t = −0.430, p = .337	t = −0.403, p = 346	t = 0.346, p = .367
Fluent	S02 (mild)	**t = −2.379, p = .016**	t = −0,753, p = .232	t = 0.242, p = .406	***t = −1.729, p = .053***
	S04 (moderate)	t = −.733, p = 238	t = −0.645, p = .265	t = −0.323, p = .376	t = −0.415, p = .342
	S06 (mild)	t = −1.148, p = .135	t = −1.291, p = .109	t = −0.323, p = .376	t = −1.522, p = .075

Bold indicates significant differences and italics indicate marginal differences.

Appendix E. Analysis of lexical verbs according to argument structure – individual differences

Group	Nº	Unergatives	Transitives	Unaccusatives
Non Fluent	S01 (mild)	t = −0.962, p = .176	t = −0.544, p = .297	t = −0.371, p = .358
	S03 (moderate)	t = −0.113, p = .456	*t = -1.672, p = .058*	t = −0.650, p = .263
	S05 (moderate)	t = 0.524, p = .304	t = −0.403, p = .346	t = −0.650, p = .263
	S07 (moderate)	t = −0.537, p = .300	**t = 1.852, p = .043**	t = −0.092, p = .464
	S08 (mild)	t = 0.312, p = .380	t = 1.429, p = .087	t = −1.208, p = .123
	S09 (moderate)	t = −0.537, p = .300	**t = -2.235, p = .021**	**t = −1.766, p = .050**
	S10 (mild)	t = 0.737, p = .237	t = 0.302, p = .384	t = −0.092, p = .464
Fluent	S02 (mild)	t = −0.750, p = .233	t = 0.020, p = .492	t = −0.929, p = .184
	S04 (moderate)	**t = 2.860, p = .006**	t = −0.121, p = .453	t = −1.487, p = .080
	S06 (mild)	**t = 2.435, p = .014**	t = −0.826, p = .211	t = −1.208, p = .123

Bold indicates significant differences and italics indicate marginal differences.

Appendix F. Post hoc analyses according to severity (Mann-Whitney tests)

Statistical analysis	Group	Results
MLU	Mild – NBDs	*U: = 1; Z = –3.186, p = .001*
	Moderate – NBDs	*U: = 0; Z = –3.273, p = .001*
Nº of Utterances	Mild – NBDs	*U: = 2.5; Z = –3.060, p = .002*
	Moderate – NBDs	*U: = .5; Z = –3.234, p = .001*
Grammaticality	Mild – NBDs	*U: = 0; Z = –3.432, p = .001*
	Moderate – NBDs	*U: = 0; Z = –3.432, p = .001*
Finiteness	Mild – NBDs	*U: = 15.5; Z = –1.925, p = .054*
	Moderate – NBDs	*U: = 0; Z = –3.279, p = .001*
Embedding	Mild – NBDs	*U = 28; Z = –0.829, p = .445*
	Moderate – NBDs	*U: = 5; Z = –2.837, p = .005*
Modals & Aspectuals	Mild – NBDs	*U: = 15.5; Z = –1.936, p = .053*
	Moderate – NBDs	*U: = 16.5; Z = –1.850, p = .066*
Unaccusative verbs	Mild – NBDs	*U = 19.5; Z = –1.593, p = .119*
	Moderate – NBDs	*U: = 16; Z = –1.891, p = .066*
Type-token ratio	Mild – NBDs	*U = 11; Z = –2.314, p = .019*
(All verbs)	Moderate – NBDs	*U: = 33; Z = –0.393, p = .735*

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