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Source / Izvornik: **Languages, 2023, 8**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.3390/languages8020120

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:257:731938

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Main Concepts in the Spoken Discourse of Persons with Aphasia: Analysis on a Propositional and Linguistic Level

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Abstract: Individuals produce discourse for various purposes as part of their daily functioning. Therefore, the ability to form a discourse should be one of the main goals of functional speech-language therapy for persons with aphasia (PwA). In addition to assessing the language skills required to form a discourse, it is important to analyse how PwA form general ideas that need to be narrated. This study had two specific aims: (1) to investigate the ability of PwA, with special consideration to the stage of their recovery—the acute and the chronic phase—to form main concepts in a discourse, and (2) to examine the relationship between the number of main concepts and different types of language measures related to productivity, informativeness, and grammaticality in all tested groups. Participants included a total of 38 persons with mild and moderate aphasia (19 in the acute and 19 in the chronic phase of recovery) and 38 healthy speakers (HS) who were matched in age, gender, and level of education. In order to effectively compare the discourse produced by the groups, a single structured stimulus was used, whereby all participants were asked to orally describe a picture from the Croatian version of the Comprehensive Aphasia Test. Compared to the HS, the main concepts produced by PwA were different in number, as well as in terms of their accuracy and completeness. However, when analysing the success in the production of the main concepts with regard to the time post-stroke—acute and chronic—the difference was not confirmed, indicating great individual differences between PwA that undermine the differences on a group level. Linguistic measures of informativeness (CIUs and CIU/words) and only one measure of grammaticality (number of clauses) showed a significant correlation with the number of main concepts in PwA. When analysing correlations for PwA in the acute and chronic phases, only CIU showed a significant association with MC, confirming it as a robust measure of discourse production in PwA. PwA did not produce long and complex sentences, and they showed difficulties in the use of verbs and the marking of argument structures.

Keywords: persons with aphasia; discourse; main concepts; propositional level; linguistic level; language measures

Citation: Kuvač Kraljević, Jelena, Ana Matić Škorić, and Karolina Lice. 2023. Main Concepts in the Spoken Discourse of Persons with Aphasia: Analysis on a Propositional and Linguistic Level. *Languages* 8: 120. https://doi.org/10.3390/languages8020120

Academic Editors: Maria Garraffa and Haiyan Wang

Received: 23 November 2022
Revised: 19 April 2023
Accepted: 23 April 2023
Published: 28 April 2023

1. Introduction

In everyday communication, speakers produce different discourse genres depending on the situation, i.e., different ways of structuring language above the sentence, such as narrating, describing, arguing, or retelling personal events. Considering the peculiarities of aphasia—an acquired neurological language disorder—such as difficulties in the retrieval of words or comprehending the instruction and limited grammatical abilities or speech fluency that affect the quality of communication (Hegde 2018), it is reasonable to assume that most persons with aphasia (PwA) will have considerable difficulties in formulating a discourse (Andreetta et al. 2012; Wright and Capilouto 2012). This can significantly affect their interaction with the environment and, consequently, their social lives.

To create a comprehensive and informative discourse, a person must integrate different types of knowledge (Andreetta et al. 2012). The speaker must consider the situation, define and introduce the topic, continuously monitor what his/her audience knows about it, maintain a coherent discourse, and possess good language skills. In addition, the speaker must introduce enough ideas and main concepts into the story to make the discourse informative. The latter is referred to as 'conceptualisation'—the process of forming general ideas to be narrated (Chafe 1990). According to Levelt and Schriffers (1987), a conceptualiser is an open set of mental processes involved in the planning of speech acts, i.e., in the encoding of a message. Coding of the message begins with the speaker's conception of some communicative intention, i.e., a goal that is to be achieved by speaking. The result at this level is a preverbal message that includes conceptual conditions for the activation of one or more lexical items and represents the input to the grammatical encoder.

The Linguistic Underpinnings of Narrative in Aphasia (LUNA; Dipper et al. 2021)—a framework developed by applying the principles of metatheory to the literature of discourse theory—places conceptualisation in the propositional category, i.e., the pre-linguistic organisational component that enters into linguistic processing. In general, the framework considers discourse production ability through four dynamic and interrelated categories: pragmatic, macrostructural planning, propositional, and linguistic. Therefore, the propositional category can be seen as a bridge between the macrostructural and microstructural levels, in which the structural organisation is filled in with conceptual ideas and transformed into a linguistic one. Given the position of the propositional category in this framework and the fact that discourse production is represented as a dynamic and simultaneous process among these four components, it can be assumed that incomplete concepts at the propositional level may affect language performance and discourse coherence. In the same manner, reduced lexical and grammatical abilities may have a crucial impact on the ability to focus on relevant aspects of events, which can affect the ability to form concepts verbally (see Dipper et al. 2005; Hameister and Nickels 2018; Soroli et al. 2012). Black and Chiat (2000) see the intertwining of these two levels as a spiral of impairment.

So far, a small number of studies have shown that PwA typically produce impoverished monologues in terms of information content (Dalton and Richardson 2019; Hameister and Nickels 2018; Nicholas and Brookshire 1995). Therefore, the present study aims to contribute new knowledge about the ability to form concepts in PwA who speak Croatian. Since the types of aphasia change dramatically over time, Laska et al. (2001) point out that it is important in research studies to identify and differentiate PwA by time since stroke onset. Therefore, in this study, PwA are considered in terms of the stage of their recovery—the acute and the chronic phase.

1.1. Informativeness of Discourse in PwA

The study by Yorkston and Beukelman (1980) was the first to report attempts to develop a method to quantify the informativeness of discourse in PwA who had moderate to mild difficulties. The authors identified a measure referred to as the content unit (CU), i.e., a grouping of information that is always expressed as a unit (p. 30), which is produced by healthy speakers (HS). They observed an inverse relationship between the severity of aphasia and the amount of information conveyed, i.e., a more severe aphasia corresponded to a reduction in the production of the total number of CUs. Based on the initial attempts of Yorkston and Beukelman (1980), Nicholas and Brookshire (1993, 1995) analysed informativeness using a considerably refined linguistic approach. They introduced the measure of the correct information unit (CIU) that was more informative than CU in terms of content. Nicholas and Brookshire (1995) analysed the discourse production of 20 PwA and 20 HS using 10 different stimuli across three sessions and confirmed that PwA exhibited lower discourse informativeness. Moreover, they emphasised the importance of analysing the number of main concepts produced by the speakers, as well as the special attention that must be given to (in)accurate and (in)complete concepts. An accurate concept means that all essential elements are correctly marked, and completeness means that each essential

element is marked in its entirety, so that not a single element is missing. They showed that the biggest difference between the performance of PwA and their healthy peers was not in the number of main concepts that an individual failed to mention, but rather the completeness and accuracy of the main concepts they produced.

Recently, researchers have begun focusing their interest on main concepts in discourse production in PwA based on different semi-structured tasks. Dalton and Richardson's study (2019) is the most comprehensive study so far in terms of semi-spontaneous discourse tasks (picture description, two sequential picture descriptions, retelling a story, and a procedure), as well as the number of participants (238 PwA and 145 HS) included to analyse the main concepts produced by PwA. The authors found that individuals with fluent and nonfluent aphasia produced significantly fewer main concepts, with this result applying to individuals with Broca's and Wernicke's aphasia. Comparatively, in patients with brain injury without aphasia, anomic aphasia, and conduction aphasia, only a slight reduction in informativeness was observed. PwA produced more accurate but incomplete main concepts, many main concepts were missing, and very few were correct. The authors noted that individuals with a brain injury but without aphasia also produced many inaccurate and incomplete main concepts. Similar results were observed in Nicholas and Brookshire (1995). Finally, Dalton and Richardson (2019) confirmed that the analysis of main concepts is sensitive enough to distinguish a person with aphasia from a healthy speaker, as well as to identify a person with a brain injury and no aphasia, but with residual language difficulties.

Hameister and Nickels (2018) investigated conceptualisation in 50 PwA (22 non-fluent and 28 fluent) based on the picture description task—a cat rescue picture (Nicholas and Brookshire 1993)—and analysed variables at the propositional and linguistic levels. The results showed that PwA exhibit a reduced amount of main information and a high amount of irrelevant information (information weakly or not at all related to the topic) in their monological discourse production. The authors proposed two explanations for this: (1) a lack of focus on relevant events, leading to the retrieval of irrelevant information, and (2) the impairment of expressive language. Despite the fact that both of these explanations are equally logical, neither of them specifies the locus of the impairment (propositional or linguistic level). Therefore, the authors examined the ability of participants to order the main concepts and found variability in the sequencing of main concepts in PwA—only one in five PwA had sequences that were significantly different from those produced by HS. The authors explained that this could occur due to the underlying conceptualisation difficulties in some PwA. Furthermore, the production of a large amount of irrelevant information in the PwA group was associated with the difference in the sequencing of main concepts.

The results of the studies conducted so far, focused on the ability to form main concepts in PwA, can hardly be generalised for at least two reasons. The first is related to the participants, in the way that these studies included different subgroups of PwA in terms of type and severity. Another reason lies in the way main concepts are measured. From the first measurement of informativeness in the study of Yorkston and Beukelman (1980) until today, there have been several attempts to establish a valid and more reliable measure of informativeness, such as the percentage of information unit (%IU, McNeil et al. 2001) or thematic informativeness and lexical information content (Marini et al. 2011). However, the application of these measures in various studies has led to contradictory results due to the following reasons: (1) Some measures refer to other discourse levels and not to the propositional level. For example, thematic informativeness, although defined as the main idea, is more closely related to the macro-level than to the propositional level. (2) Further, not all measures are equally suitable for the analysis of the informativeness of different types of discourse. For example, it is very difficult to apply informativeness to personal stories and compare the value among different speakers, because each of them presents different topics and ideas (for a more in-depth review, see Armstrong 2000; Linnik et al. 2016).

1.2. Verbal Productivity and Grammaticality of Discourse in PwA

Although conceptualisation has not been studied in detail, much more is known about the language abilities of PwA in discourse production, not only because there are several ways to measure this ability, but also because language expression is easier to access and analyse, as opposed to the abstract process of generating ideas. However, conceptualisation is associated with language skills, especially at the lexical and syntactic levels, since main concepts typically consist of a verb (lexical level) and its constituent nouns and/or prepositional phrases or other clauses that operate on the main verb to form the syntactic construction (Dalton and Richardson 2019).

Studies focusing on language measures have shown consistent results, indicating that PwA have considerable difficulties with productivity and lexical diversity. For example, while investigating discourse production based on three commonly used discourse elicitation tasks (single pictures, sequential pictures, and storytelling), Fergadiotis and Wright (2011) showed that Vocabulary Density (voc-D) as a measure of lexical diversity (LD) can discriminate PwA from HS in a way that PwA demonstrated significantly lower LD than HS. This led the authors to conclude that PwA have limited resources for accessing and retrieving lexical items. The inability to retrieve words is one of the most consistent features of aphasia, unlike agrammaticality and difficulty with repetition or comprehension, which tend to appear sporadically in the descriptions of different subtypes of aphasia. Many studies have found that verbs are especially vulnerable lexical points in PwA (e.g., Bastiaanse et al. 1996, 2002; Cruice et al. 2014), both when produced in isolation (e.g., in a structured action naming test) and in spontaneous speech. Regardless of language typology (for a comparison of Turkish and English, see Bastiaanse et al. 2011), this manifests not only in their total number, but also in their diversity (Bastiaanse et al. 1996) and inflection accuracy. In 2008, Rossi and Bastiaanse analysed spontaneous speech of Italian PwA with respect to verb production and errors and reported that PwA tend to omit verbs and make inflectional errors. In addition, compared to HS, PwA preferred to use simple verb-argument structures.

Since the core units of main concepts are verbs, it is important to observe the production of verbs, and not just of words in general, especially when trying to form a link between the conceptual and the linguistic levels. Several studies have shown a relationship between the number of verbs and the main concepts produced in a discourse (Dean and Black 2005; Hameister and Nickels 2018), indicating that verbs are good predictors of the production of main concepts. Therefore, it can be assumed that anomic difficulties, especially those related to verbs, inevitably affect the generation of main concepts in PwA, and that this may manifest in any given language.

Since lexical items retrieved from the mental lexicon have to be combined into syntactic structures in order to obtain a broad overview of conceptual/language performance, it is important to study syntactic skill as well. Producing complex syntax is particularly relevant, because it allows the speakers to express themselves more efficiently than if they were limited to producing a series of simple sentences (Nippold et al. 2014). In a series of studies, Nippold and her colleagues (Nippold et al. 2005, 2014) confirmed the stable progression of T-units in a way that they become longer and denser with age, since speakers pack more information into each unit through the increased use of subordinate clauses. It is known that some types of subordinate clauses are extremely challenging for PwA, e.g., semantically reversible sentences (e.g., non-canonical order of arguments, passives, object relatives; Martini et al. 2020); therefore, it could be expected that PwA are less successful at conveying information on a discourse level.

2. Aims of the Study

In this study, we investigate main concepts and language measures of productivity, informativeness, and grammaticality in the discourse of PwA. The motivation stems from the idea that we can obtain a more complete picture of the strengths and weaknesses of cohesive language production in PwA by considering the presence, accuracy, and

completeness of the production of main ideas, along with the linguistic efficiency with which a speaker conveys information.

Two specific aims are addressed: first, to investigate the ability of PwA—with special consideration to the stage of their recovery: the acute and the chronic phase—to form main concepts during picture description; and second, to relate their conceptual abilities to language skills. To address these aims, we compare the ability of PwA and HS—and PwA in the acute and in the chronic phase of recovery—to form main concepts and examine the relationship between the number of main concepts and different types of language measures of productivity, informativeness, and grammaticality in all groups of participants.

We hypothesise that PwA will be less successful, quantitatively and qualitatively, in marking main concepts in a spoken discourse than HS. However, looking at aphasia subgroups, we expect PwA in the chronic phase to perform better in marking main concepts during discourse production than PwA in the acute phase. In addition, we expect that the number of main concepts will be positively and significantly correlated with language measures in all groups of participants.

3. Methods

3.1. Participants

This study included 38 persons with a history of stroke in the left hemisphere whose main medical outcome was a language disorder. These patients were recruited from different clinical institutions in Croatia (see Section 3.3). The first set of inclusion criteria were that the included PwA spoke Croatian as their first language, they were premorbidly right-handed, and they had no evidence of associated memory or visual perception difficulties based on their medical reports in the institutions from which they were recruited and on the results obtained on the additional three tasks from the Cognitive Battery of the Croatian version of the Comprehensive Aphasia Test (CAT-HR; i.e., the semantic memory task, the visual recognition memory task, and the line bisection task; Swinburn et al. 2020). The second set of inclusion criteria identified participants with nonfluent aphasia who had the ability to produce at least one item in the verbal fluency task of the CAT-HR (Swinburn et al. 2020). The verbal fluency task is a prototypical task for assessing the strategic search and speedy retrieval of semantic information from semantic memory, i.e., the storage of general knowledge, schemes, and facts (Tulving 2002). In addition, participants were required to produce at least a few utterances while describing a picture. Therefore, participants who were unable to produce anything, or who produced only content words, were excluded from the study and all further analyses.

All participants were assessed based on the CAT-HR (Swinburn et al. 2020) for two reasons: (1) to confirm the presence of aphasia; and further, (2) to determine the level of severity of language difficulties. The CAT-HR test has good psychometric properties (e.g., the measures on the modality mean can discriminate 85% of PwA from HS; Kuvač Kraljević et al. 2019). Of the 38 PwA included, 24 participants had mild aphasia, as their language performance on the CAT-HR ranged from a standard deviation of -0.1 to -1, and 14 participants had moderate aphasia, as their performance ranged from a standard deviation of -1.1 to -2 from the threshold.

PwA were also selected according to the time that passed from the stroke to the process of assessment. Therefore, the sample of PwA were divided into two groups: 19 patients in the acute phase and 19 patients in the chronic phase (Table 1). Information about the type and localisation of the stroke were taken from medical histories and computerised tomography scan records. Detailed information on demographic variables (gender, age, level of education), variables related to stroke (type and localisation of stroke, time post-stroke), and speech-language status (aphasia severity, presence of additional speech disorders) are provided for each participant in the PwA groups separately in Table S1 in the Supplementary Materials.

Table 1. Demographic characteristics of PwA and HS.

	Acute (*N* = 19)	**Chronic (*N* = 19)**	**PwA (*N* = 38)**	**HS (*N* = 38)**
Gender				
Male	13 (68.42%)	13 (68.42%)	26 (68.42%)	26 (68.42%)
Female	6 (31.58%)	6 (31.58%)	12 (31.58%)	12 (31.58%)
Age				
M (SD)	54.74 (16.19)	58.34 (15.64)	56.55 (15.81)	56.91 (15.27)
Range	23–88	32–86	23–88	23–84
Education level				
8 years	1 (5.26%)	0 (0%)	1 (2.63%)	1 (2.63%)
9–12 years	12 (63.16%)	11 (57.89%)	23 (60.53%)	23 (60.53%)
>12 years	6 (31.58%)	8 (42.11%)	14 (36.84%)	14 (36.84%)
Time post-stroke (in months)	0–3	5–79	0–79	
CAT-HR M (SD)	102.24 (7.5)	99.5 (7.33)	102.79 (8.04)	
Mild—M (SD)	16 (3.94) range 101–114.88	8 (4.76) range 100.75–113.25	24 (4.31) range 100.75–114.88	
Moderate—M (SD)	3 (3.88) range 87.25–94.75	11 (4.27) range 88.13–99.38	14 (4.25) range 87.25–99.38	

Values are *n* (%) unless otherwise mentioned. M—mean, SD—standard deviation.

Due to the nature of difficulties faced by PwA, it is extremely challenging to define the main concepts of this group of respondents. Therefore, in order to set a baseline regarding the number and content of main concepts, healthy control participants were also included in the study (Richardson and Dalton 2016). Thirty-eight healthy speakers (HS) were matched with the final set of included PwA (*N* = 38) in terms of age, gender, and level of education (see Table 1).

3.2. Materials

A single structured stimulus method was applied to evoke a spoken discourse from both groups of participants and to compare their production. Here, all participants were asked to orally describe a picture from the CAT-HR (Swinburn et al. 2020, see Figure S1 in the Supplementary Materials). The decision to use this type of discourse task stems from research by Dalton and Richardson (2019), who showed that a single structured stimulus can effectively distinguish between the performance of PwA and HS. When all participants are exposed to the same topic, it is much easier to analyse the informativeness of the produced discourse by evaluating its completeness and accuracy. The picture from CAT-HR was chosen since it is the only verified tool in Croatian for testing the discourse performance of PwA and healthy adult speakers. Furthermore, there are standardised guidelines for test administration and the evaluation of participant performance based on a larger number of variables. The picture shows a little girl trying to wake up her father, who has fallen asleep, because she wants to warn him that the cat has climbed on the bookshelf, is trying to catch a fish in the aquarium, and is knocking over the books.

3.3. Procedure

3.3.1. Participant Recruitment and Testing Procedure

In accordance with the Helsinki Ethical Principles for Medical Research (WMA 2001), all participants signed a consent statement before participating in the study. Ethics approvals have been obtained from the institutions of the authors (Faculty of Education and Rehabilitation Sciences, University of Zagreb: 602-04/14-48/4; 30 May 2014, and the Polyclinic for the Rehabilitation of Listening and Speech SUVAG Zagreb: 510-08/17-20; 28 June 2017). Written informed consent was read and verbally explained to each PwA and the accompanying family member. The method of information delivery was tailored to each PwA to ensure that they fully understood the details in the consent statement. If

the PwA was unable to sign the informed consent form him/herself due to hemiparesis or limited writing ability, it was signed by a family member.

All participants were examined individually in a quiet room. The assessment and recruitment took place in several healthcare institutions for speech and language rehabilitation, including the SUVAG Polyclinic and General Hospital "Sveti Duh" in Zagreb, the Special Hospital for Medical Rehabilitation in Krapinske Toplice and Lipik, the Clinical Hospital Centres in Osijek, Rijeka, and Split, the General Hospital in Šibenik, and the County General Hospital in Požega. Patient recruitment and assessment was carried out by licensed speech-language therapists with many years of experience in working with people with neurological brain damage. The stimulus picture was placed on the table in front of the participant, who was then asked to describe it in as much detail as possible. The discourse productions of all participants were recorded as audio samples. After recruiting the PwA, the same investigators recruited healthy speakers as part of the control group using the same protocol.

3.3.2. Transcription Methodology

After all recordings were collected, three independent transcribers (all three authors) transcribed the transcripts (each author transcribed one-third of all transcripts) and analysed them as follows:

1. All transcripts were checked in such a way that only utterances related to the content of the picture were included. All personal comments of the PwA and HS (e.g., *I don't know what else to say, I don't know what it is*) were excluded from further analyses.
2. The 'cleaned transcripts' were then reviewed to identify and list the content units, i.e., relevant statements that contain only one verb and convey information about the picture (Nicholas and Brookshire 1995; Hameister and Nickels 2018). Each of the three independent raters (all three authors) analysed one-third of the transcripts and segmented the utterances into relevant concepts. From each rater, one-third of the transcripts were randomly selected and assigned to another rater for evaluation. In other words, three independent raters randomly exchanged one-third of their transcripts to check for agreement between raters. The results show that the 38 HS produced 363 relevant concepts, and the agreement between the raters was 96%, whereas the 38 PwA produced 264 relevant concepts, and inter-rater agreement was 92%. All disagreements were resolved by consensus.
3. Using relevant concepts produced by HS, three independent raters (all three authors) identified the phrases that expressed the same meaning despite being worded differently. For example, *The cat was catching a fish from the aquarium* and *The cat grabs the fish* both stand for the concept *Cat wants to catch a fish from the aquarium*. After all the concepts of the HS were identified, all phrases that made up one concept were combined. Based on this procedure, 29 concepts were identified from the discourse production of HS (see Table S2 in Supplementary Materials).

3.3.3. MC Coding and Variables

1. Using the criterion mentioned in Richardson and Dalton (2016), the main concept (MC) could be considered essential if it was mentioned by at least 30% of participants. All concepts that were produced by HS at this percentage served as the baseline for analysing the ideas expressed by PwA. In this step, only nine out of twenty-nine MCs satisfied this criterion (see Table S2 in Supplementary Materials).
2. MCs are structures that consist of two or more essential elements—minimally, a verb and its constituent nouns or/and prepositional phrases or other clauses that operate on the main verb (Dalton and Richardson 2019). Using the established MC lists, stories produced by all speakers were scored for the presence or absence of MCs, as well as for the accuracy and completeness of the MCs present. Coding procedures proposed by Nicholas and Brookshire (1995) and later refined by Dalton and Richardson (2019) were utilised:

(a) Missing MCs were coded as absent (AB).
(b) MCs that were present (P) could receive one of four codes based on their accuracy and completeness: the AC code was assigned if all essential elements were accurate (A) and complete (C); the AI code was assigned if all essential information that was produced was accurate (A), but one or more of them were missing, i.e., incomplete (I); the IC code was assigned if all essential elements were present and complete (C), but some essential elements were inaccurate (I) based on the control speakers' productions; and finally, the II code was assigned if one or more essential elements were incomplete (I), and one or more of the essential elements that were produced were inaccurate (I) (see Table S3 in the Supplementary Materials; Richardson and Dalton 2016). In the present study, the inter-rater agreement in assigning codes was overall 89% for all groups combined. All disagreements were resolved by consensus.

3.3.4. Specific Language Measures—Coding and Variables

All narratives produced were analysed at the linguistic level, applying eight different language measures as indicators of productivity, informativeness, and grammaticality (Bryant et al. 2016):

(1) Number of words—words had to be intelligible in the context, but did not have to be accurate, relevant, or informative relative to the eliciting stimulus (Nicholas and Brookshire 1993);
(2) Number of verbs—all verbs were counted separately. For example, similar to English, in Croatian, all modal verbs require the main verb in the infinitive form (*on želi jesti—he wants to eat*), and these two verbs in modal constructions were treated as two separated verbs;
(3) Number of correct information units (CIU)—words had to be accurate, relevant, and informative relative to the eliciting stimulus; they did not have to be used in a grammatically accurate manner to be counted as ClUs. Each CIU consisted of a single word, and only words that were included in the word count could be counted as CIUs (Nicholas and Brookshire 1993);
(4) Ratio of verbs per words—since main concepts consist of a verb, it was important to determine the share of verbs in the total lexical production;
(5) Ratio of CIU per words—this ratio provides an insight into how many, out of the total words produced, are directly related to the informative content of discourse production;
(6) Number of clauses—a string of words that includes a subject and a predicate;
(7) Number of T-units (terminable unit)—the shortest grammatically allowable sentence that consists of one main clause and any attached subordinate clauses (Hunt 1970; Nippold et al. 2008);
(8) Clausal density—the only measure that was calculated as the average number of clauses produced per T-unit.

After the transcripts were segmented into T-units and coded for clauses, all words, verbs, and CIUs were counted, and all transcripts again checked by the authors. Inter-rater agreement for all measures exceeded 90%. All disagreements in segmenting or coding were resolved by consensus during several joint discussions.

4. Results

Before conducting any analyses, a Kolmogorov–Smirnov test was used to assess whether the variables were normally distributed. All variables but one (*N of words* in the HS sample) showed a deviation from the normal distribution (alpha value set at $p = 0.05$). Therefore, in all subsequent analyses, nonparametric methods were used, specifically, a Mann–Whitney U test and Spearman's rank correlation coefficient test.

Analyses were performed in accordance with the aims of the study. First, descriptive data were obtained for the number of MC, and between-group differences were calculated. Then, the frequency of each code for all nine MCs was provided for each group, and

between-group differences were investigated. Furthermore, descriptive data for the eight language variables and between-group differences were obtained. Finally, correlation analyses were performed between the number of MCs and all analysed language variables separately for each group of participants. In line with the aims of the study, all between-group analyses were first performed between PwA and HS, and then between PwA in the acute and PwA in the chronic phase of recovery. The latter step is crucial to determine different patterns in the performance of PwA with regard to time post-stroke.

4.1. Production of Main Concepts

In the first step, we investigated the average number of main concepts (N of MCs) produced by HS and PwA (as a whole group and separately as PwA in the acute and in the chronic phase of recovery) and HS (Table 2).

Table 2. Average number of main concepts produced by the participants.

Variable	Group	*N*	M	SD	Min	Max
N of main concepts	HS	38	4.71	1.49	2.00	8.00
	PwA whole	38	2.87	1.34	1.00	6.00
	PwA acute	19	3.26	1.15	1.00	6.00
	PwA chronic	19	2.58	1.43	1.00	5.00

From Table 2, it can be seen that the participants in the HS group produced more main concepts than those in the PwA group. Apart from the high average score, the range of results (SD) was wider in the HS group. When the performance of PwA in the acute and in the chronic phase of recovery was observed separately, somewhat higher mean scores were obtained by those in the acute phase of recovery, but with the greater variance in the PwA in the chronic phase.

We further tested whether the differences in the N of MC produced by the HS and PwA were significant. The results confirmed that this is the case (U = 1172.00; z = 4.755; $p < 0.001$); HS produced significantly more main concepts than the PwA (see Table 2). Next, we compared PwA in the acute and chronic phase. The two groups did not differ on this variable ($U = 130$, $z = -1.513$; $p = 0.146$), indicating that they produce a similar number of main concepts in a discourse. Error bars that represent the means and standard deviations of this variable for PwA and HS can be found in Figure S2 in the Supplementary Materials.

4.1.1. Presence and Omissions of Main Concepts

The next step was to determine the frequency (calculated as percentages) with which each MC was present or absent in the discourse production of HS and PwA (as a whole and group and, specifically, as PwA in the acute and in the chronic phase of recovery) (Table 3).

In addition to the large percentage of absent MCs—in the sense that they were not marked by PwA who were tested in the acute and in the chronic phase—Table 3 shows that if Richardson and Dalton's (2016) criterion of setting a 30% threshold for the essential MCs was applied to the number of MCs marked by PwA, only three MCs would pass that threshold for both PwA groups: MC3, MC6, and MC8. Additionally, MC5 passed that threshold for the PwA in the acute phase, but not for the PwA in the chronic phase. We refer to this further in the Discussion.

4.1.2. Accuracy and Completeness of the Produced Main Concepts

As noted in Nicholas and Brookshire (1995), it is important not only to analyse the number of MCs produced by the speakers, but also to pay particular attention to their completeness and accuracy. With this in mind, we analysed all present (P) MCs marked by PwA and HS and assessed how they marked them in terms of accuracy and completeness (Table 4).

Table 3. Percentage of absent (AB) and present (P) main concepts.

Main Concept	Group	Code AB (%)	Code P (%)
MC 1	HS	65.8	34.2
	PwA whole	76.3	23.7
	PwA acute	73.7	26.3
	PwA chronic	78.9	21.1
MC 2	HS	68.4	31.6
	PwA whole	89.5	10.5
	PwA acute	89.5	10.5
	PwA chronic	89.5	10.5
MC 3	HS	36.8	63.2
	PwA whole	42.1	57.9
	PwA acute	36.8	63.2
	PwA chronic	47.4	52.6
MC 4	HS	60.5	39.5
	PwA whole	81.6	18.4
	PwA acute	73.7	26.3
	PwA chronic	89.5	10.5
MC 5	HS	29	71
	PwA whole	71	29
	PwA acute	63.2	36.8
	PwA chronic	78.9	21.1
MC 6	HS	39.5	60.5
	PwA whole	52.6	47.4
	PwA acute	42.1	57.9
	PwA chronic	63.2	36.8
MC 7	HS	68.4	31.6
	PwA whole	74.7	5.3
	PwA acute	89.5	10.5
	PwA chronic	100	0
MC 8	HS	10.5	89.5
	PwA whole	21.1	78.9
	PwA acute	21.1	78.9
	PwA chronic	21.1	78.9
MC 9	HS	50	50
	PwA whole	79	21
	PwA acute	84.2	15.8
	PwA chronic	73.7	26.3

Table 4. Percentages of types of codes given to each of the nine MCs produced by PwA and HS, along with between-group differences calculated using *t*-test for proportions.

Main Concepts	Group	Code II (%)	*t*-Test	Code IC (%)	*t*-Test	Code AI (%)	*t*-Test	CODE AC (%)	*t*-Test
MC 1	PwA	33.33	t = 2.24; p = 0.03 *	0	t = −1.23; p = 0.22 ns	66.67	t = −0.95; p = 0.34 ns	0	t = 1.93; p = 0.054 ns
	HS	0		15.39		46.15		30.77	
MC 2	PwA	25	t = 1.79; p = 0.07 ns	25	t = 0.87; p = 0.38 ns	25	t = 1.15; p = 0.25 ns	25	t = 0.31; p = 0.77 ns
	HS	0		8.33		58.33		33.33	
MC 3	PwA	0	-	13.04	t = −1.83; p = 0.07 ns	26.09	t = −2.68; p = 0.01 **	60.87	t =−3.41; p = 0.001 **
	HS	0		0		0		100	
MC 4	PwA	14.29	t = 1.55; p = 0.12 ns	14.29	t = 0.58; p = 0.56 ns	71.43	t = −1.99; p = 0.04 *	0	t = −2.93; p = 0.002 **
	HS	0		6.67		26.67		66.67	
MC 5	PwA	27.27	t = 2.15; p = 0.03 *	36.36	t = 3.31; p = 0.00 **	27.27	t = 1.24; p = 0.21 ns	9.09	t = 4.41; p < 0.000 **
	HS	3.7		0		11.11		85.19	
MC 6	PwA	16.67	t = 2.08; p = 0.04 *	33.33	t = −1.98; p = 0.04 *	5.56	t = 0.18; p = 0.86 ns	44.44	t = −2.90; p = 0.004 **
	HS	0		8.69		4.35		86.96	
MC 7	PwA	50	t = 2.54; p = 0.01 **	0	t = −0.62; p = 0.54 ns	0	t = −0.62; p = 0.54 ns	50	t = −0.46; p = 0.65 ns
	HS	0		16.67		16.67		66.67	
MC 8	PwA	20	t = 2.74; p = 0.006 **	0	t = −1.35; p = 0.18 ns	70	t = −3.01; p = 0.003 **	10	t = 4.27; p < 0.000 **
	HS	0		5.88		32.35		61.76	
MC 9	PwA	12.5	t = 1.57; p = 0.12 ns	12.5	t = 1.57; p = 0.12 ns	25	t = 2.27; p = 0.02 *	50	t = −3.34; p = 0.000 **
	HS	0		0		0		100	

Code II, inaccurate/incomplete; Code IC, inaccurate/complete; Code AI, accurate/incomplete; Code AC, accurate/complete (see Section 3.3.3), * statistical significance at the <0.05 level, ** statistical significance at the <0.01 level.

As seen in Table 4, different patterns of between-group differences were observed for different MCs with respect to the given codes. No significant differences were found in any code with respect to MC2. For the codes MC1 and MC7, there was a significant difference only in Code II (inaccurate/incomplete), with the PwA group producing more incomplete and inaccurate markings of these concepts than the HS group. Furthermore, for the codes MC3, MC4, and MC9, between-group differences were observed for the Codes AI (accurate/incomplete) (assigned to PwA more often) and AC (accurate/complete) (assigned to HS more often). Finally, for three MCs (MC5, MC6 and MC8), the differences between the groups were found for the three types of codes in different combinations depending on the MC. In all three MCs, AC (accurate/complete) was found significantly more often in the HS group, whereas all other codes were assigned to the PwA group more often than to the HS group. The above results allow us to confirm our hypothesis that PwA are less successful than HS in marking main concepts, i.e., in verbally expressing conceptual ideas.

Since certain differences in the percentage of present MCs were descriptively observed between PwA in the acute and in the chronic phase of recovery (Table 3), we further explore different patterns in the types of codes given to each MC for the two PwA groups (Table 5).

Table 5 shows that the two PwA groups performed rather similarly, i.e., most of the analyses showed no significant differences in the codes given for the way they marked the 9 MCs. The only two significant differences were obtained for the MC3 (code IC) and MC6 (code AC). Concretely, PwA in the chronic phase produced more complete but inaccurate markings of the concept MC3 than PwA in the acute phase. Moreover, PwA in the acute phase produced more complete and accurate markings of the concept MC6 than PwA in the chronic phase.

Since we expected that PwA in the chronic phase will perform better in marking main concepts during discourse production than PwA in the acute phase, this hypothesis cannot be accepted.

Table 5. Percentages of types of codes given to each of the nine MCs produced by PwA in the acute and PwA in the chronic phase, along with between-group differences calculated using *t*-test for proportions.

Main Concepts	Group	Code II (%)	*t*-Test	Code IC (%)	*t*-Test	Code AI (%)	*t*-Test	Code AC (%)	*t*-Test
MC 1	PwA acute	0	t = −1.805; p = 0.07 ns	0	-	26.3	t = 1.775; p = 0.077 ns	0	-
	PwA chronic	15.8		0		15.8		0	
MC 2	PwA acute	0	t = −1.017; p = 0.308 ns	5.3	t = −1.017; p = 0.308 ns	0	t = −1.017; p = 0.308 ns	5.3	t = −1.017; p = 0.308 ns
	PwA chronic	5.3		0		5.3		0	
MC 3	PwA acute	0	-	5.3	t = −2.946; p = 0.003 **	21.1	t = 1.439; p = 0.149 ns	36.8	-
	PwA chronic	0		47.4		5.3		36.8	
MC 4	PwA acute	0	t = −1.017; p = 0.308 ns	5.3	t = −1.017; p = 0.308 ns	21.1	t = 1.439; p = 0.149 ns	0	-
	PwA chronic	5.3		0		5.3		0	
MC 5	PwA acute	10.5	t = 0.594; p = 0.555 ns	15.8	t = 1.054; p = 0.294 ns	5.3	t = 0.594; p = 0.555 ns	5.3	t = −1.017; p = 0.308 ns
	PwA chronic	5.3		5.3		10.5		0	
MC 6	PwA acute	0	t = −1.805; p = 0.07 ns	21.1	t = 0.896; p = 0.368 ns	0	t = −1.017; p = 0.308 ns	36.8	t = 2.382; p = 0.017 *
	PwA chronic	15.8		10.5		5.3		5.3	
MC 7	PwA acute	5.3	t = −1.017; p = 0.308 ns	0	-	0	-	5.3	t = −1.017; p = 0.308 ns
	PwA chronic	0		0		0		0	
MC 8	PwA acute	15.8	-	0	-	63.2	t = 0.979; p = 0.327 ns	0	t = −1.805; p = 0.07 ns
	PwA chronic	15.8		0		47.4		15.8	
MC 9	PwA acute	0	t = −1.017; p = 0.308 ns	0	t = −1.017; p = 0.308 ns	0	t = −1.451; p = 0.147 ns	15.8	t = 1.054; p = 0.294 ns
	PwA chronic	5.3		5.3		10.5		5.3	

Code II, inaccurate/incomplete; Code IC, inaccurate/complete; Code AI, accurate/incomplete; Code AC, accurate/complete (see Section 3.3.3), * statistical significance at the < 0.05 level, ** statistical significance at the <0.01 level.

4.2. Productivity, Informativeness, and Grammaticality in a Spoken Discourse

In the second part of the analyses, we focused on the measures of productivity, informativeness, and grammaticality. Descriptive data and between-group differences were calculated for the eight observed language measures (Tables 6 and 7). Similar to the previous step, we were first motivated to investigate the differences between the PwA and HS, and later to focus on the differences between the PwA in the acute and in the chronic phase of recovery.

Table 6 presents the descriptive statistics and differences between the PwA and HS on the analysed language measures. Error bars that represent the means and standard deviations on language measures for both samples can be found in Figure S2 in the Supplementary Materials.

Table 6 shows that the average scores of the HS group are higher than of PwA (one exception is the ratio of verbs per words). Although it was not in the scope of our analysis, it is interesting to mention that PwA produce incomplete clauses and clauses consisting of a number of neologisms, in addition to a lower number of clauses overall. Neither of these was recorded in the discourse production of HS. The between-group analysis (Mann–Whitney U test) proved that the differences between the groups were significant for all measured variables but the ratio of verbs per words, in favour of HS (Table 6).

Moreover, variability (SD) is relatively high and consistent for some variables in both groups (e.g., N of words); for others, variability is much greater in the HS group (e.g., CIU). This means that participants in these two groups differ greatly in the number of words produced, but also that healthy participants differ among themselves in the amount of correct information units produced. The production of the PwA group is less variable in this respect, as they generally find it difficult to produce a CIU.

Table 6. Performance of PwA and HS based on a number of analysed language measures (counted and calculated) and between-group differences.

Variable	Group	N	M	SD	Min	Max	Between-Group Differences
N of words	PwA	38	30.55	16.37	8.00	78.00	$U = 424.5$; $z = -3.257$; $p = 0.002$ **
	HS	38	44.39	21.63	17.00	107.00	
N of verbs	PwA	38	9.18	6.57	2.00	30.00	$U = 436$; $z = -2.981$; $p = 0.003$ **
	HS	38	12.89	6.64	5.00	33.00	
N of CIU	PwA	38	19.38	9.75	6.00	50.00	$U = 182$; $z = -5.614$; $p = 0.000$ **
	HS	38	42.16	20.78	17.00	99.00	
Verbs/words	PwA	38	0.30	0.09	0.10	0.51	$U = 690$; $z = -0.333$; $p = 0.739$
	HS	38	0.29	0.06	0.18	0.43	
CIU/words	PwA	38	0.69	0.21	0.24	1.00	$U = 156$; $z = -5.944$; $p = 0.000$ **
	HS	38	0.95	0.08	0.57	1.00	
N of clauses	PwA	38	6.29	3.23	1.00	16.00	$U = 337.5$; $z = -4.026$; $p = 0.000$ **
	HS	38	9.79	3.95	4.00	19.00	
N of T-units	PwA	38	5.47	3.20	1.00	16.00	$U = 484.5$; $z = -2.492$; $p = 0.013$ **
	HS	38	7.16	3.60	2.00	16.00	
Clausal density	PwA	38	1.22	0.35	1.00	2.33	$U = 404$; $z = -3.257$; $p = 0.001$ **
	HS	38	1.48	0.45	1.00	2.66	

** Statistical significance at the <0.01 level.

We were motivated to further explore whether the PwA in the acute and in the chronic phase of recovery differ with respect to the eight language measures. Despite the relatively big differences with respect to time post-stroke, the Mann–Whitney U test showed that the two groups do not differ in any of the analyses (Table 7).

Despite the lack of significant differences, Table 7 shows interesting patterns on a strictly descriptive level. PwA who were tested in the chronic phase of recovery achieved somewhat higher overall mean scores on six measures, two of which reflect productivity (N of words and N of verbs), one of which reflects informativeness (N of CIU), and all three measures that reflect grammaticality (N of clauses, N of T-units, and clausal density). Further, the variability of results (SD) in this group is greater, as well as the maximum scores that some individuals obtained on certain language measures. This suggests that the variability of language abilities in PwA, expressed in individual differences, becomes more evident after the end of the acute phase, i.e., three or more months after the onset of the stroke.

4.3. Correlations between Main Concepts and Language Measures of Productivity, Informativeness, and Grammaticality

Using the nonparametric Spearman's Rho coefficient, the correlations between the number of MCs and different types of language measures of productivity, informativeness, and grammatical complexity were analysed separately for each group. Since it is interesting to observe the patterns of this relation with respect to the phase of recovery, we also performed the correlation analyses separately for the two groups of PwA. The results are presented in Table 8.

Table 7. Descriptive statistics and differences between PwA in the acute and chronic phase of recovery in the eight language measures.

Variable	Group	N	M	SD	Min	Max	Between-Group Differences
N of words	PwA acute	19	26.42	11.56	8.00	53.00	$U = 220$; $z = 1.154$; $p = 0.258$
	PwA chronic	19	34.68	19.52	11.00	78.00	
N of verbs	PwA acute	19	8.42	5.55	2.00	27.00	$U = 194$; $z = 0.396$; $p = 0.708$
	PwA chronic	19	9.95	7.53	2.00	30.00	
N of CIU	PwA acute	19	17.74	7.05	7.00	31.00	$U = 207.5$; $z = 0.789$; $p = 0.435$
	PwA chronic	19	21.42	11.86	6.00	50.00	
Verbs/words	PwA acute	19	0.31	0.09	0.10	0.51	$U = 138.5$; $z = -1.228$; $p = 0.223$
	PwA chronic	19	0.28	0.91	0.13	0.45	
CIU/words	PwA acute	19	0.73	0.23	0.24	1.00	$U = 135$; $z = -1.329$; $p = 0.191$
	PwA chronic	19	0.66	0.18	0.27	0.95	
N of clauses	PwA acute	19	6.05	2.44	2.00	11.00	$U = 183.5$; $z = 0.089$; $p = 0.931$
	PwA chronic	19	6.53	3.94	1.00	16.00	
N of T-units	PwA acute	19	5.21	2.35	2.00	10.00	$U = 184$; $z = 0.104$; $p = 0.931$
	PwA chronic	19	6.53	3.94	1.00	16.00	
Clausal density	PwA acute	19	1.21	0.38	1.00	2.33	$U = 179$; $z = 0.269$; $p = 0.822$
	PwA chronic	19	1.23	0.33	1.00	2.00	

Table 8. Correlation between the number of MCs and language measures in the group of HS, PwA, and PwA in the acute and chronic phase of recovery.

Group	HS		PwA Whole		PwA Acute		PwA Chronic	
Measure	N of MC							
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
N of words	0.531	0.001 **	0.154	0.357	0.068	0.782	0.261	0.280
N of verbs	0.479	0.002 **	0.262	0.113	0.183	0.454	0.382	0.106
N of CIU	0.537	0.001 **	0.476	0.002 **	0.538	0.018 *	0.469	0.043 *
Verbs/words	−0.023	0.892	0.109	0.515	−0.057	0.816	0.188	0.440
CIU/words	−0.168	0.315	0.384	0.017 *	0.443	0.058	0.238	0.326
N of clauses	0.501	0.001 **	0.343	0.035 *	0.300	0.212	0.436	0.062
N of T-units	0.356	0.028 *	0.136	0.414	0.020	0.934	0.238	0.326
Clausal density	0.068	0.683	0.214	0.204	0.438	0.061	0.097	0.702

* Statistical significance at the <0.05 level, ** statistical significance at the <0.01 level.

As expected, all counted language measures are significantly related to the number of MCs in the HS group. Only the three calculated measures are not, suggesting that ratio measures may not be sensitive enough as those counted directly from the discourse material (Table 8). When PwA are observed as a group, there is a moderately significant correlation between the number of MCs and three language variables: the number of CIUs, the number of clauses, and the ratio of CIU per words. However, despite the fact that the reduction in the N of participants consequently affects the power of the analyses and reduces the possibility of significant results, it is nevertheless theoretically and

methodologically more appropriate to observe the groups of PwA separately. This analysis revealed that in both PwA samples—those in the acute and those in the chronic phase of recovery—the only measure that correlates with the number of produced MCs is the number of CIU. Scatterplots for significant correlations can be found in the Supplementary Materials (Figures S3a–e and S4a–c).

Since MCs are structures that consist of two or more essential elements—minimally, a verb and its constituent nouns and/or prepositional phrases or other clauses (Dalton and Richardson 2019)—we hypothesised that their number would be positively correlated with the language measures. Our hypothesis can be partially confirmed, since this was not the case for the majority of measures in the PwA group or for some measures in the HS group.

5. Discussion

The present study represents an endeavour to connect two categories of discourse processing in aphasia—propositional and linguistic. Drawing on the Linguistic Underpinnings of Narrative in Aphasia framework (LUNA, Dipper et al. 2021), which places conceptualisation at the propositional level—the level that provides the link between the structural elaboration of the spoken narrative discourse and its linguistic encoding—we wanted to examine the ability of PwA to generate the main concepts of a narrated story and to linguistically mark them. The main concepts are content units that exceed the threshold criterion of an occurrence of more than 30% (Richardson and Dalton 2016). By using the description of a picture as a single structural stimulus, we provided a controlled discourse condition for the generation of concepts and their language marking to two groups of participants, PwA and HS (controls).

In this study, we considered only mild and moderate aphasia from two post-stroke recovery phases—acute and chronic—because it is in these severity levels that language production is mostly possible. In the in-depth analyses of the main concepts, as well as in the analyses of the language measures and correlation analyses, the two PwA groups were observed separately to obtain a comprehensive overview of their performance with respect to the phase of recovery. Nevertheless, in line with the aims of the study, they were also treated as one group when their performance was compared with that of HS.

By analysing one conceptual measure—the number of main concepts produced—and eight language measures belonging to three different measurement categories—productivity (number of words, number of verbs, and ratio of verbs per words), informativeness (number of CIUs and ratio of CIU per words), and grammaticality (number of clauses, number of T-units, and causal density)—we aimed to investigate (1) the ability of PwA, especially considering the two subgroups of aphasia, to produce main concepts and (2) the relationship between the number of main concepts and different types of language measures related to productivity, informativeness, and grammaticality in all tested groups.

5.1. Production of Main Concepts

The results obtained in the present study are consistent with previous studies aiming to determine the informativeness of discourse among PwA (Dalton and Richardson 2019; Hameister and Nickels 2018; Nicholas and Brookshire 1995). As expected, PwA produced significantly fewer MCs in relation to the HS. However, a more detailed analysis provided interesting insights. If the 30% threshold criterion from Richardson and Dalton (2016) had been applied on the discourses produced by the PwA group in the present study, only three out of the nine MCs can be considered for further analysis (MC3, MC6, and MC8). Our analyses revealed that 47.4% of PwA marked MC6, 57.9% marked MC3, and 78.9% marked MC8. When these MCs were converted into story content, PwA recognised three key events: that the father is sleeping (MC3), that the little girl is trying to wake him up (MC6), and that the cat wants to catch the fish from the aquarium (MC8). Since PwA produced the crucial events, two indirect conclusions can be derived: (1) PwA can develop a story idea on a conceptual level that subsequently needs to be linguistically realised, and

(2) PwA do not produce somewhat less relevant concepts, i.e., those that are related to the story, but not crucial for the story to be understood—this indicates that their discourse production is determined by their limited cognitive and linguistic resources. The latter conclusion can also be alternatively explained with those theoretical approaches such as the adaptive theory (Kolk 1995), which claim that persons with nonfluent aphasia simplify the message as a self-controlled reaction to limited cognitive and linguistic capacities. By doing so, they prevent overload and reduce the occurrence of errors (either on the lexical, morphological, or syntactic level). Therefore, it can be assumed that the focus on the most important concepts and the omission of the less relevant ones by PwA in this research could be a consequence of the way they adapt to the difficulties they have.

A deeper analysis of the MCs that were present in the discourse of PwA shows that their production of main concepts is not just different with respect to the number of MCs produced in comparison to HS, but also with respect to their accuracy and completeness. The analysis of the quality of MCs produced by the PwA showed that these concepts are very often accurate but incomplete, inaccurate but complete, or both inaccurate and incomplete: in many instances, those between-group differences were statistically significant. In the linguistic marking of the main concepts by PwA, three patterns can be observed (Table 4), each of which characterises three MCs (the performance of HS is referred to here as an established baseline and for comparison):

(1) MC1, MC2, and MC7—these three MCs are the ones with the lowest percentage of marking in both groups (5.3–23.7% in PwA and a little above 31% in HS for all three). This indicates that out of the nine extracted MCs, these three seem to be the least important, because they are related to the description of the space and setting up the context. The only significant difference between PwA and HS was observed in Code II for two concepts, MC1 and MC7. This indicates that when PwA decided to mark MC1 and MC7, these concepts were more often inaccurate and incomplete compared to the marking by HS. Due to the extremely low percentage of marking in both groups, no difference was observed for MC2 for any code.

(2) MC3, MC4, and MC9—we found that MC4 and MC9 are moderately represented in HS and barely in PwA, whereas MC3 is represented to a greater extent in both groups. For these three concepts, significant differences were found for two codes: Code AC, which states that the HS group is significantly more successful, as they mark these concepts entirely accurately and more completely than PwA; and Code AI, for which PwA produced accurate but incomplete concepts more often than HS. This means that PwA omitted some language elements while forming the MC. For example, they said: *She wakes up* (object missing—*the father*); *The cat knocks down* (object missing—*books*); and so on.

(3) MC5, MC6, and MC8—in HS, MC6 and MC8 are the most frequently expressed concepts, whereas it is MC8 in the PwA group. MC6 is moderately frequent in both groups. There was a significant difference between the two groups in all four codes: in Code AC for all three MCs, for which HS marked these MCs more accurately and completely than PwA; Code AI was significant only for MC8, implying that the PwA were more likely to leave out something when marking this concept, because the MC was not completed. For example, *The cat catches* (missing object—*fish in an aquarium*). The significant difference in the Code IC appeared in MC5 and MC6, for which PwA had more problems with the correct lexical marking of the concept. For example, The girl *calls* him by the hand, instead of *pulls* him. Code II was significantly different between the groups for all three concepts, which means that the PwA often marked these concepts inaccurately and incompletely. For example, *The fox is hunting. She wants to take this jelasa** (a neologism).

Regarding the first specific objective of this study—to investigate and compare the ability of PwA and HS to form main ideas—it can be stated that although PwA produce fewer MCs than HS, they are still able to form a chain of related concepts that are formed as ideas at the conceptual level. When marking MCs linguistically, i.e., when verbally

expressing conceptual ideas, they show two common problems: (1) retrieving words from their mental lexicon (e.g., the word is missing, it is retrieved incorrectly, or an incorrect word is retrieved) or producing a neologism, and (2) not completing the verb with all its argument structures, especially objects. For example, they often say *The cat is chasing* (an object is missing—*whom*?) or *The girl is pointing* (an object is missing—*at whom*?). The latter indicates the omission of some parts of the sentence, such as the pronoun in the object function, which is a consequence not only of lexical retrieval difficulties, but also difficulties in syntactic processing.

Starting from the evidence in the literature that time post-stroke plays an important role in the language outcome (Laska et al. 2001), and that individuals in a later stage of recovery present less severe language disabilities (Johnson et al. 2019, 2022; Osa García et al. 2020), we decided to examine whether there were differences between the acute and chronic PwA in our sample. However, the results showed that there was no significant difference between them in marking the main concepts, i.e., in expressing conceptual ideas verbally. A more detailed analysis of MCs present in the discourse of PwA in the acute and chronic phases showed that one more main concept (MC5) in the production of PwA in the acute phase exceeded the threshold. This subgroup of PwA produced this main concept and recognised that the *little girl warns father*. Additional analyses regarding the accuracy and completeness of the main concepts produced showed that the two subgroups of aphasia are relatively similar in terms of the number of incorrect and incomplete concepts. The differences are observed only for two main concepts, in so far as PwA in the chronic phase produced more complete but inaccurate main concepts. The fact that we found no differences between PwA in terms of the stage of recovery after stroke can be explained in two ways. First, research suggesting that PwA are more successful at the chronic stage has confirmed such results at lower language levels, such as naming. Discourse goes beyond the word and sentence level and is much more sophisticated, i.e., linguistically and structurally more complex. For this reason, more time may be required to recover this ability. Second, in our sample, there were more subjects with moderate aphasia in the chronic group and more with mild aphasia in the acute group. Therefore, it is possible that the interaction between stroke-related factors and the severity of aphasia affects language outcomes in both subgroups of PwA. This has also been confirmed in other studies (Pedersen et al. 2004; Plowman et al. 2012; Saber-Moghadam et al. 2022).

5.2. Trade-Offs in Discourse between MC and Linguistic Encoding

In order to be able to tell a story, in addition to the generated idea on the conceptual level, a narrator needs to have a diverse vocabulary and must possess the grammatical knowledge and means to mark words, as well as the syntactic knowledge to form sentences on a local and global level.

As expected, the groups differed significantly in most of the analysed language measures, i.e., seven out of eight observed: those that represented productivity (number of words and number of verbs), informativeness (number of CIUs and ratio of CIU per words), and grammaticality (number of clauses, number of T-units, and causal density), with PwA obtaining lower scores in all measures. The only measure that they did not differ in was the ratio of verbs per words. Both groups had a similar outcome, but different reasons behind it. PwA generally produced fewer words, and therefore fewer verbs, as well. On the contrary, HS produced significantly more words in general, and among these words are verbs, as well as other word types. Furthermore, the correlation analysis showed that all counted language variables—number of words, verbs, CIU, clauses, and T-units—were significantly moderately related to the number of marked MCs in the control group of HS. In order to linguistically mark the generated concept, the narrator has to retrieve the necessary words from his/her mental lexicon, especially those that are meaningful and informative for the story, and combine them grammatically into utterances. The utterances of HS were also syntactically more complex, i.e., in addition to the main clause, we often observed a dependent clause. A greater number of dependent clauses also means a greater number

of verbs, which then brings dynamics to the story and ensures a clearer definition of the cause–effect event relationships. It is important to emphasise that the moderate correlation between the number of MCs and the total word count results not only from the fact that a lexicon is needed for the linguistic marking of MCs, but also from the fact that healthy speakers use highly diverse word types in their narratives both in terms of grammatical complexity and informativeness. Their discourse often contains not only the words that are crucial for the main message of the story, but also those somewhat less relevant ones, i.e., those that set up the scene, explain the context, and describe some other details of the story.

In the PwA group, only three measures—the number of CIUs, the number of clauses, and the ratio of CIU per word—showed a significant correlation with the number of marked MCs. These data again suggest that PwA, having generated only the most essential ideas of the story, focus their cognitive resources on retrieving the words that have a high degree of informativeness and form them into a series of sentences. The lack of correlations with other measures reflects the way that PwA shape a discourse—they do not produce long and complex sentences, nor do they mark much of the events that are not relevant to the main point of the story. Often, their syntactic structures consist only of main clauses without a dependent clause. Even when they try to form a dependent clause, they often have problems with it, mainly with the verb, so they abandon further production (e.g., *The cat chases the fish aahh book*—the verb *pushes* is omitted). Difficulties in the use of verbs and their marking of argument structures in PwA are also indicated by Cruice et al. (2014), who in their study asked PwA to talk about personal experiences and quality of life, or by Rossi and Bastiaanse (2008), who analysed the connected speech of Italian PwA.

Verb production of PwA has been analysed in many studies (Bastiaanse et al. 1996; Bastiaanse and Jonkers 1998; Bastiaanse et al. 2002, 2011; Rossi and Bastiaanse 2008, to name only a few). Overall, the data points to the fact that PwA, especially agrammatic PwA, produce fewer and less diverse verbs compared to the HS. They also find it more difficult to recall verbs than nouns. It seems that their verb production is affected regardless of language typology (with differences becoming more evident or being more diverse in more complex systems), especially in spontaneous production, whereby this affects all other aspects of the story in a connected spoken production. Verbs contain more grammatical information than nouns, especially in inflectional languages such as Croatian. Therefore, people with nonfluent aphasia, who often have a grammatical disorder in their clinical picture, will find it difficult to recall words that are more grammatically complex (Zingeser and Berndt 1990). However, it is important to emphasise the influence of different features of verbs and the context in which they appear on the success of their retrieval and use by PwA. Research has shown that people with nonfluent aphasia, more precisely agrammatic aphasia, will find it more difficult to recall verbs in a sentence and discourse context than at the level of the word (Thompson et al. 1997; Bastiaanse and Jonkers 1998). They will also find it more difficult to recall verbs that are transitive rather than intransitive (Jonkers and Bastiaanse 1996), and they will use verbs with a less complex argument structure more often, i.e., they prefer to use verbs with only one or no internal arguments (Thompson et al. 1997; Rossi and Bastiaanse 2008, etc.).

Difficulties in verb retrieval and the characteristics of the verbs required to express the main concepts in this picture description task can partially explain our results. First, the presence of verbs is the main criterion variable for computing most of the measures in this study (e.g., main concept, ratio of verbs per words, number of clauses, number of T-units). The absence of verbs in such expressions automatically resulted in the absence of other variables in the mentioned measures. For example, in some utterances, an attempt to express a concept or a sentence was visible (for example, *Dice the floor.*; *A cat is ev . . . everything.*), but due to the lack of verbs, such utterances were not analysed. The lack of verbs expressed by PwA can partly explain the results obtained on measures of informativeness and grammaticality compared to the HS. Second, it is possible that the characteristics of the verb or the use of different synonyms for the target verb influenced the frequency of expression of a particular concept by PwA. For example, some concepts

appeared frequently in PwA, such as the concept *The father is sleeping*, because the verb *to sleep* is a high-frequency verb that has only one argument structure. In comparison, for the concept *The cat catches the fish in the aquarium*, although the verb has several argument structures and is high in frequency, it also allows for the use of synonyms (e.g., *wants to catch, catches, wants to eat, grabs*, etc.), which made it easier for PwA to retrieve one verb among several alternatives and to express the concept. Third, when we considered how a person tries to express a concept and how they do it in relation to completeness and accuracy through quantitative analysis and qualitative inspection of the data, we found that PwA had more responses that were incomplete than those that were complete, regardless of accuracy. This may indicate that even when PwA managed to retrieve an adequate verb, they very often dropped its arguments (e.g., *The man lies (where?)*; *(Who?) sleeps in the armchair*; *(Who?) catches a fish (where?), and the daughter pulls, for sure, (whom?) by the sleeve*; *And the little girl wants to tell (whom?) what the kitty is doing*, and so on). It is also well documented in the literature that nonfluent PwA are poor in verb inflection compared to HS (Bastiaanse and Jonkers 1998; Bastiaanse et al. 2011). Two of the least mentioned concepts by PwA were MC2 (*The girl was playing with toys*) and MC7 (*The cat climbed up on the shelf*), which are the only concepts that actually happened before the observed scene, and therefore should be expressed in the past tense. The need to mark in the past tense may be one reason why these concepts were rarely marked—when they were marked, it was often in the present tense, which is grammatically simpler. Since several syntactic features need to be controlled simultaneously when marking the past tense, such as the correct tense inflection, the position of the copula, or the order of all words, it is also possible that PwA make more errors in marking this verb construction due to its complexity (Friedmann and Grodzinsky 1997; Jonkers and Bruin 2009).

It is well known that narrative tasks can elicit greater syntactic complexity than conversational tasks in different populations—children and adults of various ages with typical and atypical language development (e.g., Nippold et al. 2005, 2008, 2014). Although simple stimulus material was used here to generate the story, PwA produced very modest discourses. Since the syntactic length and complexity is dependent on many factors, such as the ability of lexical retrieval and verb production, as well as on the verb argument structure, the scarce number of clauses and utterances that consisted of the main clause and any attached subordinate clauses produced by the PwA did not come as a surprise. Simplifying the message to formulate the most important concepts, as mentioned earlier (i.e., Kolk's (1995) adaptation theory), leads to structural simplification of sentences, as well. This also means that PwA consciously use more ellipses, an acceptable form of expression for healthy speakers, in order to avoid many morphological and constructional errors and thereby improve the fluency of their speech. However, despite these adaptation attempts, PwA still show difficulties, evident in the language measures. Some of the PwA that obtained the lowest results on the analysed language measures often produced isolated words to name the recognised objects (fewer times, actions) in the picture (*Cup of (red) coffee; The flower, the window, the paper under table; . . .*). Action naming sometimes appeared without the subject (e.g., *Sleeps*), but these instances can be observed differently depending on the context. Since Croatian is a pro-drop language that allows for a noun/pronoun to be omitted, which is more common in the reference to the subject, if a person introduces the subject and in subsequent sentences omits the pronoun, that is not considered agrammatical. However, if the subject had not been introduced previously, this would be categorised as a grammatical error and would not be marked as a clause. Moreover, the presence of incomplete clauses may indicate that some PwA have the intention to produce more complex structures but lack adequate linguistic elements to do so. The abovementioned reasons also lead to the smaller subordination index, i.e., lesser clausal density in comparison to the control group of healthy individuals.

A difference between PwA with regards to time post-stroke was not observed on any language measures. This indicates that regardless of how long the PwA have been experiencing language difficulties, individual differences between subjects in a number of

other variables, e.g., medical variables—such as the size of the lesion or the presence of other disorders—or therapeutic variables—such as the dosage and duration of the therapy—are critical for success in language performance and certainly had an impact on the results obtained in this study. Correlation analyses confirmed only the relationship between the number of produced MCs and the number of CIU for both subgroups. This relationship again confirmed that, regardless of time post-stroke, PwA try to generate only the most essential ideas of the story and focus their cognitive resources on retrieving the words that have a high degree of informativeness. Once these words are retrieved, they are combined into a limited number of sentences in order to be later recognised as main concepts. In this way, CIU as a measure of informativeness is confirmed as a robust measure of discourse production in PwA.

5.3. Clinical Implications

In the field of speech-language pathology, increasing efforts are now being made to assess not only discrete language abilities, but also functional communication. This is primarily because functional communication is more sensitive to the presence of a language disorder in individuals who have had a stroke, as well as to recovery or the effect of various therapeutic approaches and methods. For example, some studies have shown that progress on separate language skills measured with standardised tests is minimal (Marini et al. 2011) or non-existent (Larfeuil and Dorze 1997), whereas discourse analysis has shown improvement in communicative effectiveness, i.e., more informative discourse (Helm-Estabrooks and Ramsberger 1986; Marini et al. 2011). This points to the fact that discourse analysis is a more suitable measure for assessing predictors of functional communication (Armstrong et al. 2007; Larfeuil and Dorze 1997). In other words, by analysing a person's discourse, one can recognise subtle difficulties, even in patients whose performance on a standardised test does not indicate the presence of aphasia (see Dalton and Richardson 2015). Nevertheless, the time and knowledge required to collect and transcribe the sample, as well as to select and apply appropriate measures and methods for analysing and interpreting the results, often remain a challenge for many researchers, and especially clinicians. A detailed analysis of the main concepts and their association with various measures of language is beneficial for testing the usefulness of these measures for diagnostic purposes with respect to assessing the discourse production of individuals with aphasia.

At this point, it is important to emphasise that a language-based intervention should precede a functional communication intervention, because the former supports communication skills through strengthened language skills. Thus, the immediate clinical implication of this paper is that intervention should occur to restore the verb repertoire and its inflectional features, so that PwA can more accurately and completely mark main concepts as conceptual units that need to be verbally encoded.

In the present study, we used the picture description task from the standardised Croatian version of the Comprehensive Aphasia Test (CAT-HR). We did this intentionally, because we wanted to show that different instruments designed for assessment can be used in parallel as a valuable source of additional information that falls outside the scope of diagnostic assessment. Using the task from this test, we controlled the administration and transcription process of the audio sample. By applying various empirically confirmed discourse measures, we were able to gain insights into the discourse production abilities of PwA.

5.4. Study Limitations and Future Perspectives

Despite the clear theoretical and clinical findings elaborated in the Discussion, the present study has certain limitations that should be addressed.

A single-picture description represents a structured way of collecting a sample of discourse of PwA. Such a highly structured stimulus allows for the collection of a language sample that is predictable in both content and language, and therefore can be easily com-

pared among individuals or groups (Bryant et al. 2016). However, it does not reveal the actual language abilities of PwA as would be visible through some other discourse genres, such as conversation (Bryant et al. 2016), which is the most representative genre of language use (Armstrong 2000). Therefore, in future research, it would be useful to combine different discourse genres to obtain a broader view of the discourse abilities of PwA.

Given that verb retrieval and verb usage is a considerable problem for PwA, and the fact that the use of verbs was the most important requirement for the calculation of certain variables in this study, we believe that simply counting the number of verbs is not a sufficient measure to show the connection with other measures and explain the differences between the PwA and HS groups. Results of other studies have also shown that PwA do not differ from HS in the number of verbs in spontaneous speech, but they differ in their diversity: HS produce more diverse verbs in their narratives (Bastiaanse and Jonkers 1998). Although PwA produced significantly less verbs than HS, the measure of lexical diversity would further explain the connection with the measure of informativeness.

Furthermore, the accuracy and completeness of the main concepts were analysed only from the point of view of informativeness, and not from the point of view of morpho-syntactic accuracy. Discourse analysis through the application of additional quantitative and qualitative measures, such as morpho-syntactic accuracy, could provide a clearer answer regarding the connection between the expression of verbs and the expression of main concepts. Finally, for a more comprehensive insight into the ability of PwA to form main concepts, it is necessary to investigate their ability to recognise and comprehend them in a given discourse, as well.

6. Conclusions

This study aimed to investigate the ability of PwA to form the main concepts of a story and to relate their conceptual abilities to language skills. The motivation for this approach stems from the theoretical framework of the Linguistic Underpinnings of Narrative in Aphasia (LUNA; Dipper et al. 2021): here, conceptualisation belongs to the propositional category or the pre-linguistic organisational component that enters into linguistic processing. As noted by Dipper et al. (2021), comprehensive and collaborative research of different categories of the framework are needed in order to validate it with empirical findings for the purpose of gaining a better understanding of the model of spoken language production. Moreover, many studies conducted so far highlighted the research and clinical importance of discourse analysis in PwA, since it may provide important insights into different processing levels of this population, which is why it should be combined with other tasks targeting isolated word finding. Our findings point to several important conclusions. Firstly, PwA have a limited language ability to express all main concepts in a single stimulus picture. Even when they mark a concept, they do so to a significantly lesser extent than their age-, gender-, education-matched healthy peers. A difference between PwA in the acute and chronic phases in expressing conceptual ideas verbally was not found. Secondly, main concepts produced by PwA are very often incorrect or incomplete and inadequately linguistically marked. Their inability to form even the simplest structures may partly be related to their word retrieval deficits, which is evident at both the noun and verb level, with the latter affecting other language measures to a greater extent. In addition to the differences observed in only two main concepts—in the way that PwA in the chronic phase produced more complete but inaccurate main concepts—additional analyses regarding the accuracy and completeness showed that the two subgroups of PwA are relatively similar in terms of the number of incorrect and incomplete concepts. Despite the somewhat limited number of measures used to relate the propositional level to the linguistic one, this study confirmed that in PwA, these two categories of discourse production show a spiral of impairment (Black and Chiat 2000). Even when these individuals understand the concept of the story, their language disorder proves disadvantageous when it comes to linguistically marking the story. Future studies

should combine different tasks and methods of elicitation of spoken narratives to conduct more in-depth analyses and extend current findings.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/languages8020120/s1.

Author Contributions: Conceptualisation: J.K.K.; Methodology: J.K.K., K.L.; Analysis: J.K.K., A.M.Š.; Writing—Original Draft Preparation: J.K.K., A.M.Š., K.L.; Writing—Review and Editing: J.K.K., A.M.Š., K.L.; Supervision: J.K.K. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the Croatian Science Foundation—Project Adult Language Processing (HRZZ-2421-UIP-11-2013).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical reasons.

Acknowledgments: The authors thank the Collaboration of Aphasia Trialists, which is funded by COST and the Tavistock Trust for Aphasia, for their support in setting research priorities and promoting international/multidisciplinary collaboration in aphasia research. The authors acknowledge the administrative and financial support provided by the Faculty of Education and Rehabilitation Sciences, University of Zagreb.

Conflicts of Interest: The authors declare no conflict of interest.

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