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COHERENCE IN APHASIA: IMPLEMENTATION OF DIFFERENT MEASUREMENT PROCEDURES

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COHERENCE IN APHASIA: IMPLEMENTATION OF DIFFERENT MEASUREMENT PROCEDURES[3]

Coherence is a semantic property of the text to make sense to readers or listeners and is crucial for any text. Various coherence measures have been developed for assessment of discourse abilities in different clinical populations. However, the results of decades of research on coherence of speech of individuals with brain damage have yielded contradictive results. We suggest that this might be due to the different sensitivity of the methods.

In this study we two measures of global coherence and five measures of local coherence on the same set of texts by healthy speakers of Russian and people with dynamic aphasia in order to find which methods allow to distinguish between the two groups and how these results correlate.

The material for the study is texts from the Russian CliPS corpus which is a collection of oral retellings of the pear film by individuals with brain damage and healthy speakers of Russian language.

Keywords: coherence, discourse macrostructure, aphasia, oral corpora.

JEL Classification: Z

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Introduction

Discourse is not merely a set of sentences; it is a set of sentences that are connected in some way: discourse is organized hierarchically and can be described as having micro- and macrostructure. Microstructure of discourse refers to the surface representation of discourse, such as lexical, grammatical and prosodic features, as well as the level of single discourse units (such as propositions, clauses or verbalizations) and their relations with other units (Kintsch and van Dijk, 1978), while macrostructure is the organization of discourse on a global level. Microstructure is supported by means of cohesion, that is, language devices that provide a connection between discourse units, such as pronouns, ellipsis, lexical repetition (Halliday and Hasan, 1976). Coherence is a semantic property of the text to make sense to readers or listeners and is crucial for any text. Coherence is a semantic property of the text to make sense to readers or listeners Discourse coherence is a mental phenomenon, it involves negotiation between the speaker/writer and the addressee (or representation of the addressee) and establishing common ground on topicality, reference and thematic structure (Jucker, 1997).

Most approaches distinguish two types of coherence: local and global. Global coherence is understood as a composite phenomenon, mostly related with the topic continuity in discourse (Givón, 1995). Local coherence describes the relationship and logical connectedness of units in discourse (Grosz, Joshi and Weinstein, 1995). Both global and local coherence can be

Texts differ in the level of coherence. One of the reasons for low coherence of discourse can be lowered in speech of people with various neurologic and psychiatric conditions, such as schizophrenia (Barch and Berenbaum, 1997; Marini *et al.*, 2008), Alzheimer's disease (Dijkstra *et al.*, 2004) and aphasia (Linnik, Bastiaanse and Höhle, 2015).

Despite many years of research on speech pathologies, the relation between certain language deficits on lexical and grammatical level and the ability to construct and comprehend coherent discourse is not clearly established yet and remains an open question (Armstrong, 2000; Wright, 2011). On the other hand, some neurological conditions, though not leading to diagnosed speech pathologies, such as lesions in right hemisphere of right-handed persons, result in problems with understanding and producing coherent narratives (Brookshire and Nicholas, 1984; Tompkins *et al.*, 1997).

There are a number of approaches to calculating the coherence measure of a given text based on different properties of a discourse that is perceived as a coherent one. The goal of our study is to establish an approach to coherence leading to a result that is most consistent with native speaker

intuition. To this end, we test several approaches on our corpus of data and introduce our own method created with respect to methods already described and our linguistics and language intuition of coherence.

The purpose of the study is to identify coherence deficits in dynamic aphasia. We will evaluate different aspects of coherence with various methods established in previous research as well as using our method created with respect to methods already described and our linguistics and language intuition of coherence.

We analyzed the texts produced by people with aphasia and neurologically healthy speakers. All the texts are produced as an answer to the same stimuli given to all the respondents of the study. The set of these texts now exists in the form of a corpus and are used in other types of discourse analysis.

Material and Method

Material

The Russian CliPS corpus

The Russian Clinical Pear Stories (Russian CliPS) corpus is the first corpus of Russian narratives (film retellings) by individuals with brain damage – people with aphasia (PWA) and right hemisphere damage (RHD) – and neurologically healthy speakers of Russian language (Khudyakova *et al.*, 2016). The Russian CliPS corpus contains multi-layer annotation of audio- and video-recordings, performed on micro- and macro-linguistic level, and can be used as a source for qualitative and quantitative research on various aspects of speech in aphasia and RHD.

The elicitation stimulus, the Pear film[i], was made at the University of California in Berkeley in 1975 specifically for elicitation and collection of narratives by people from various cultures and languages (Chafe, 1980). The Pear film has been widely used for discourse elicitation by linguists for the last 40 years (see for example (Chafe, 1980; Erbaugh, 1990; Helasvuo, 1993; Reed, 2000; Kumagai, 2006; Hsu and Chiu, 2008; Orero, 2008; Blackwell, 2010; Mazur and Kruger, 2012; Bergelson *et al.*, 2015). For the Russian CliPS corpus all speakers were asked to watch the film and then retell it in detail to the person who had not seen it before (the listener could be present at the time of the retelling, or the experimenter told the speaker that a person would listen to the recording afterwards).

The Russian CliPS corpus contains 10 stories by individuals with each type of aphasia: efferent motor, dynamic, sensory aphasia and acoustic-mnestic aphasia; as well as 5 stories by individuals with RHD and 22 stories by neurologically healthy speakers. Individuals with brain damage all were at least 6 months post-stroke; all the participants were right-handed, native speakers of Russian language, had at least a high school education, and had normal or corrected-to-normal vision, and no hearing problems.

The current version of Russian CliPS contains 66 narratives. The total length of the recorded material is 4 hours 33 minutes. The mean length of each recording is 4 minutes 7 seconds (min – 38seconds, max – 18 minutes 27 seconds, SD = 175 seconds). The annotation of the corpus was performed in ELAN (Wittenburg *et al.*, 2006). The annotation scheme includes basic tiers (transcript and grammar), segmentation into discourse units, and specific tiers for non-verbal sounds, interaction markers, and errors.

The subcorpus

For the coherence analysis 18 texts from the Russian CliPS corpus were chosen: 8 texts by speakers with dynamic aphasia (4 females; mean age – 52; range – 41-68; SD = 9.0) and 10 texts by neurologically healthy speakers (3 females; mean age 57; range – 25-78; SD = 16.4), see Table 1 for detailed information.

Dynamic aphasia is one of the types with non-fluent speech output, characterized by impairment of internal planning of an utterance, which results in overall production deficit (Akhutina, 2015).

Demographic characteristics of neurologically heathy speakers

Text ID	Age	Sex	Education
HP-v03	male	63	higher
HP-v04	male	42	postgraduate degree
HP-v05	female	75	higher
HP-v10	male	78	higher
HP-v13	female	55	higher
HP-v15	male	73	postgraduate degree
HP-v21	male	62	higher
HP-v22	female	49	higher
HP-v25	male	25	secondary
HP-v27	male	52	vocational

Demographic characteristics of speakers with dynamic aphasia			
Text ID	**Age**	**Sex**	**Education**
AP-s01	f	51	vocational
AP-s02	m	45	vocational
AP-s03	f	47	secondary
AP-s04	m	56	vocational
AP-s06	m	41	higher
AP-s23	f	53	higher
AP-s27	m	56	higher
AP-v25	f	68	higher

Table 1. Demographic information on speakers of the analyzed subcorpus.

Segmentation

Each text is segmented into elementary discourse units (EDUs) and utterances. An EDU is defined as a clause, with a predicate (a finite verb, predicative word, or participle), or an omitted predicate. An utterance consists of an EDU with its dependent EDUs (for example, relative clauses). Different methods of coherence evaluation use EDUs or utterances as a basic discourse unit.

Coherence scoring

5-point scale

One of the most popular ways to measure local and global coherence is to use a scoring scale and assign a coherence score to every discourse unit. Glosser and Deser (1990) proposed a 5-point rating scale: each discourse unit is rated from 1 to 5 on the connectedness to the topic of the discourse (global coherence) and to the immediately preceding unit (local coherence). We use the adapted version of this scale proposed by Van Leer and Turkstra (1999) and later used by Coelho and Flewellyn (2003), see Table 2. We apply the scoring to each utterance.

Global coherence	
1	The utterance is unrelated to the general topic or is a comment on the discourse.
2	The utterance contains multiple clauses, wherein one clause possibly relates to the topic and the other does not.
3	The utterance provides information possibly related to the general topic or is an evaluation statement without providing substantive information, or the topic must be inferred from the statement.
4	The utterance contains multiple clauses, wherein one clause relates directly to the topic and the other relates indirectly.

5	The utterance provided substantive information related to the general topic.

Local coherence	
1	The utterance has no relationship to content of the immediately preceding article.
2	The utterance contains multiple clauses, wherein one possibly relates to the content of the preceding utterance but the other(s) may not.
3	The utterance topic generally relates to that of the preceding utterance, but with a shift in focus from a subject or activity of the preceding utterance, or the utterance is referentially vague or ambiguous so relation to the preceding utterance must be inferred.
4	The utterance contains multiple clauses, wherein one clause relates directly to the content of the preceding utterance but the other(s) may not.
5	The topic of the preceding utterance is continued by elaboration, temporal sequencing, enumeration of related examples, or maintaining the same actor, subject, action, or argument as a focus.

Table 2. Rating scales for global and local coherence, cited from (Coelho and Flewellyn, 2003).

Coherence violations

While the focus of the scoring procedure is overall evaluation of the text's coherence, the violation detection approach concerns only with incoherent points in discourse. We adopt the violation counts suggested by Christiansen (1995) that take into account both local and global coherence. Incoherence on local level is evaluated by counting violations of completeness and violations of progression.

Violations of completeness are the propositions missing from the text. Since the narratives in the corpus are retellings of a film, the list of important propositions was created based on the script of the film (see Table 3 for the full list). Omission of a proposition from the list was annotated as a violation of completeness.

1. The farmer gathers pears from the tree.
2. The boy steals a basket of pears.
3. The boy meets a girl and falls with his bike.
4. A group of local boys help the boy to collect pears and find his hat.
5. The local boys receive pears.
6. The farmer notices that one basket is missing.
7. The farmer sees the local boys eating his pears.

Table 3. List of important propositions.

Violations of progression are repetitions of propositions which do not contain any new information, even when their lexical components are different.

The global coherence is evaluated by counting violations of relevance, that is, all utterances that contain information not relevant for the general topic, such as comments on discourse, irrelevant propositions, etc.

Logical coherence

Establishing logical coherent relations, a method described a method described in Davis & Coelho (2004), is a method for measuring local coherence. For each EDU its relation to another EDU is established based on criterion of necessity, adopted from Trabasso & van den Broek (1985): physical, motivational, psychological and enablement relations. The resulting score is the proportion of EDUs that are related to others to the total amount of EDUs in a text.

Logical tree

The previously described methods either establish coherence between the segments that immediately precede each other (the five-point scale) or do not take discourse structure into account (logical coherence). However, discourse is organized hierarchically and relations between discourse units can be represented in a form of a tree. For example, Rhetorical structure theory (RST) offers a framework with a set of symmetrical (nuclear) and asymmetrical (satellite) discourse relations: 23 relations in the original version (Mann and Thompson, 1987) and more than a 100 in more recent interpretations (Carlson, Marcu and Okurowski, 2003). Though RST can be applied to narratives by people with aphasia (Linnik, Bastiaanse and Khudyakova, 2015), annotation of oral narratives is quite time- and labor-consuming.

We propose a simplified version of a discourse tree structure where units are connected to each other based on the criteria adapted from Coelho and Flewellyn (2003): elaboration, temporal sequencing, enumeration of related examples, or maintaining the same actor, subject, action, or argument as a focus. An EDU can be related to any other segment in a text based on these criteria, and every relation to a segment that is located in a higher position is considered appropriate. We score as coherence violations EDUs that are not related to any other EDU in a text (except the first one) or relations that result in crossing the branches of a tree. The resulting score is the proportion of EDUs that are related to others to the total amount of EDUs in a text.

Results

Global coherence

Global coherence measures included five-point scale scoring, and identification of violations of completeness. The scores for each narrative are shown in Table 4.

Neurologically heathy speakers		
Text ID	**5-point scale score**	**Violations of completeness (ratio)**
HP-v03	5.00	0.00
HP-v04	4.86	0.00
HP-v05	5.00	0.00
HP-v10	5.08	0.14
HP-v13	4.53	0.00
HP-v15	4.29	0.14
HP-v21	5.00	0.00
HP-v22	4.27	0.14
HP-v25	4.39	0.14
HP-v27	4.75	0.00
average	*4.72*	*0.06*
SD	*0.32*	*0.07*
Speakers with dynamic aphasia		
Text ID	**5-point scale score**	**Violations of completeness (ratio)**
AP-s01	4.08	0.00
AP-s02	3.62	0.29
AP-s03	3.72	0.00
AP-s04	4.66	0.00
AP-s06	4.55	0.00
AP-s23	4.50	0.00
AP-s27	4.30	0.00
AP-v25	4.25	0.00
average	*4.21*	*0.04*
SD	*0.38*	*0.10*

Table 4. Global coherence scores for neurologically healthy speakers and speakers with dynamic aphasia

Mann-Whitney test revealed significant differences between the two groups on global coherence five-point scale scores ($U=13$, $p<0.05$ two-tailed) and no difference for violations of completeness ratings ($U=31$, $p>0.05$ two-tailed). Also we have found no significant correlations between the two measures ($r = -0.3975$; $p>0.05$).

Local coherence

Global coherence measures included five-point scale scoring, and identification of violations of progression and relevance, logical coherence and logical tree coherence ratios. The scores for each narrative are shown in Table 5.

Neurologically heathy speakers					
Text ID	**Five-point scale**	**Violations of progression (ratio)**	**Violations of relevance (ratio)**	**Logical coherence (ratio)**	**Logical tree coherence (ratio)**
HP-v03	4.78	0.21	0.54	0.96	0.65
HP-v04	4.79	0.07	0.14	1.00	0.63
HP-v05	4.83	0.16	0.29	0.96	0.53
HP-v10	5.00	0.08	0.08	1.00	0.75
HP-v13	4.83	0.15	0.27	0.94	0.74
HP-v15	4.10	0.12	0.24	0.99	0.61
HP-v21	4.90	0.00	0.00	0.96	0.85
HP-v22	4.21	0.05	0.23	1.00	0.92
HP-v25	4.24	0.03	0.13	1.00	0.83
HP-v27	4.55	0.00	0.00	0.98	1.02
average	*4.62*	*0.09*	*0.19*	*0.98*	*0.75*
SD	*0.33*	*0.07*	*0.16*	*0.02*	*0.15*
Speakers with dynamic aphasia					
Text ID	**Five-point scale**	**Violations of progression (ratio)**	**Violations of relevance (ratio)**	**Logical coherence (ratio)**	**Logical tree coherence (ratio)**
AP-s01	3.06	0.33	0.19	0.13	0.80
AP-s02	3.06	0.00	0.27	0.03	1.03
AP-s03	3.58	0.06	0.28	0.18	0.87
AP-s04	3.87	0.09	0.00	0.17	0.94
AP-s06	3.19	0.18	0.23	0.12	0.92
AP-s23	4.00	0.20	0.07	0.18	1.00
AP-s27	3.83	0.17	0.00	0.04	0.39
AP-v25	3.52	0.14	0.08	0.15	0.86
average	*3.51*	*0.15*	*0.14*	*0.13*	*0.85*
SD	*0.38*	*0.10*	*0.12*	*0.06*	*0.20*

Table 5. Local coherence scores for neurologically healthy speakers and speakers with dynamic aphasia

Speakers with aphasia scored significantly lower than the healthy speakers group on five-point scale ratings ($U = 0$, $p<0.05$ two-tailed), and logical coherence ($U = 0$, $p<0.05$ two-tailed), but the difference was not significant for logical tree coherence measures ($U = 21.5$, $p>0.05$ two-tailed), violations of progression ($U = 25$, $p>0.05$ two-tailed) or violations of relevance ($U = 32.5$, $p>0.05$ two-tailed). The correlation between logical coherence and five-point scale ratings was found to be significant ($r = 0.8617$; $p<0.05$); however, the logical tree scores did not correlate with five-point scale scores ($r = -0.3554$; $p>0.05$) or logical coherence scores ($r = -0.2506$; $p> 0.05$).

Discussion

The main focus of our study was to compare different methods for measuring coherence in discourse that were previously applied to study of coherence in aphasia (Glosser and Deser, 1990; Christiansen, 1995; Van Leer and Turkstra, 1999; Coelho and Flewellyn, 2003), as well as to test a novel scoring measure using logical trees.

The applied methods can be generally divided in two groups: those that apply rating system and provide an overall score for the text and those that focus on detecting violations of local or global coherence. The results show that scoring methods provide results that are consistent with previous findings reporting lower coherence in aphasic speech (Ulatowska *et al.*, 1983; Christiansen, 1995). However, other methods which focus on coherence violation detection did not show significant differences between groups of healthy speakers and speakers with aphasia. This can explain the contradictive results of studies on coherence in aphasia (see Linnik, Bastiaanse and Höhle, 2015 for comparison), given that the some methods are more sensitive than others.

However, the comparison of measures gives rise to the question about the nature of coherence as a linguistic phenomenon. If there are no evident violations of coherence in aphasic speech, why are the coherence rating scores significantly lower? Coherence is a result of interplay of many micro- and macrolinguistic factors, and the lower scores can be explained by the influence of microlinguistic factors rather than the discourse structure.

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[i] http://www.linguistics.ucsb.edu/faculty/chafe/pearfilm.htm