WHAT COGNITIVE MECHANISMS IMPACT LANGUAGE COMPREHENSION IN INDIVIDUALS WITH APHASIA?

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Background

Aphasia **is a complex acquired communication disorder caused by brain damage, characterized by an impairment of language modalities: speaking, listening, reading, and writing at various linguistic levels; it is not the result of a sensory or a motor deficit, a general intellectual deficit, or a psychiatric disorder (Hallowell & Chapey, 2008; Homskay, 2003)**

But it is not only about language - ***nonlinguistic deficits are also observed in aphasia:***

- **deficits of attention (**the more attention is required to perform a language task, the harder it becomes for individuals with aphasia **)** (Hula & McNeil, 2008);
- **reduced memory capacity (**negatively impacts language comprehension**)** (Wright & Fergadiotis, 2012);
- **negative impact of concurrent memory load or on-going interference (**strongly affects accuracy and speed of linguistic processing in aphasia**)** (Murray, 1999).

Aim of the study - investigate the simultaneous influence of different cognitive mechanisms (memory, attention, speed of processing) on auditory language comprehension in individuals with fluent and non-fluent aphasia.

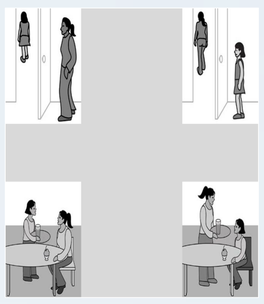
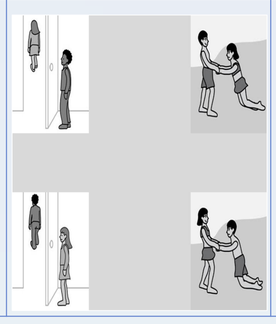
Methods

Participants:
Thirty four right-handed native speakers of Russian with aphasia following left hemisphere CVA:
15 with non-fluent aphasia (47,4 ± 12,9 years), 19 with fluent aphasia (54,9 ± 12,4 years).

Tests (all verbal material was presented in Russian):

1. **Working memory was assessed with the MLS task** (the Modified Listening Span task; Ivanova & Hallowell, 2013)
Listen to sentences and remember a separate set of words for later recall (sets of sentences and words become progressively longer: from 2 to 6).

Score – proportion of correctly recognized elements per set.

Verbal stimuli	The girl is serving the woman.	Sweater	The boy is leaving the girl.	Pumpkin	(recognition display)
Visual stimuli		Blank screen		Blank screen	

2. **STM** (Short-term memory)
Repeat progressively longer sequences of syllables in the same order
e.g.: BET-LNU; MOS-RIN-LAH

Score – proportion of correctly recalled syllables per set.

3. **Ability to focus and sustain attention**
Listen to sequences of numbers (pseudorandom raging from 1 to 9 (four sets, 150 numbers in each) and press the button when a specified sequence is heard, e.g., "1, 5"
«2 – 7 – 4 – 1 – 7 – **1 – 5** – 9 – 3 – 2 – 5 – 6 – 8 – 1 – 4 – 5 – 1 – 9 – 3 – **1 – 5** – 8 – 6 ….»

Score – number of correct responses; reaction time for the correct behavioral response.

4. **Ability to switch attention**
Count two types of sounds (H - high (2000Hz, 500Msec) and L - low (250Hz, 500Msec)) that were presented in randomized sequences. After each sound push a button to proceed to the next one. One set has from 7 to 9 sounds (in all there are 30 sets). At the end of each set state the number of each type of sound.
«H → H → L → H → L → L → H → H → H» → **? H – 6, L – 3**

Score – number of correct counts; reaction time between sounds.

5. **Reaction time**
Press the button as soon as possible when a target signal is heard

cued signal ⟶ target signal
(random interval from 1-3 sec)

Score – reaction time from the presentation of a target signal to the behavioral response.

6. **QASA** (the Quantitative Assessment of Speech in Aphasia (Tsvetkova, Ahutina, & Pulaeva, 1981)
This comprehension part of the test includes five subtest:
a) comprehension of questions about activities of daily routine;
*b) comprehension of nouns (*match series of nouns (from one to three words) to pictures*);*
*c) comprehension of verbs (*match series of verbs (from one to three words) to pictures*);*
d) comprehension of sentences;
e) follow verbal instructions

Score – number of correct items.

Results

- No significant differences on cognitive tasks were observed between the two aphasia groups (*p* > ,2).
- To determine how cognitive factors jointly impact language comprehension simultaneous multiple linear regression with auditory comprehension score on the QASA as the dependent variable was conducted separately for fluent and non-fluent aphasia

Predictors (cognitions)	*F*	*β*	*p*	R^2
Non-fluent aphasia	**8,411**		**,006**	**,787**
Short-term memory		-,331	,157	
Working memory		**,506**	**,022**	
Ability to focus and sustain attention (number of correct responses)		**,704**	**,029**	
Ability to focus and sustain attention (reaction time)		,290	,386	
Ability to switch attention (number of correct counts)		,242	,417	
Ability to switch attention (reaction time)		**-,616**	**,006**	
Reaction time		**,970**	**,033**	
Fluent aphasia	2,060		,137	,292
Short-term memory		,312	,170	
Working memory		,207	,352	
Ability to focus and sustain attention (number of correct responses)		,050	,857	
Ability to focus and sustain attention (reaction time)		,233	,323	
Ability to switch attention (number of correct counts)		-,364	,254	
Ability to switch attention (reaction time)		-,047	,829	
Reaction time		**-,646**	**,021**	

Discussion

- Data obtained in this study demonstrated an array of cognitive deficits in individuals with aphasia:
  - They experienced difficulties with accuracy and speed of information processing, decreased memory capacity, and impairments in sustained and focused attention.
- Individuals with fluent and non-fluent aphasia demonstrated differential impact of various cognitive processes (memory, attention, speed of processing) on auditory language comprehension:
  - For individuals with non-fluent aphasia working memory span, sustained attention, efficiency of attention switching, and speed of processing each made a unique and a significant contribution to language comprehension. This data is supported with numerous non-linguistic interpretations of non-fluent (agrammatic) aphasia, where overall slowed rate of information processing, along with reduced processing capacity are postulated to play a pivotal role in the observed language deficits;
  - For individuals with fluent aphasia only speed of processing made a significant contribution. This finding is consistent with studies suggesting that a lexical-semantics deficit plays a central role in this type of aphasia while concomitant cognitive deficits remain secondary.

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