

Lexical processing and working memory in individuals with and without aphasia

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Traditionally comprehension difficulties in non-fluent aphasia (NFA) have been regarded as syntactic in nature. However, individuals with NFA have been found to have considerable delay in lexical processing (Prather et al., 1997). In recent studies breakdowns in comprehension in NFA have also been explained as difficulties in lexical integration (Choy & Thompson, 2009, 2010). It remains unclear whether these emerging difficulties in lexical processing are primarily linguistic in nature or whether they are influenced by impairment of other cognitive processes, such as memory and attention (Friedmann & Gvion, 2003, 2012; Wright & Fergadiotis, 2012). The current study was designed to further tap into the time course of lexical processing in healthy controls and in NFA. We also aimed to investigate the potential role of working memory (WM) in efficiency of lexical integration.

To investigate lexical processing stories with temporally ambiguous sentences were employed in an eye-tracking-while-listening paradigm. All linguistic stimuli were presented in Russian. A story included two introductory sentences (1a), then a sentence with an ambiguous word (1b), and a disambiguation region (1c):

- 1a. *After the concert, the singer decided to have fun. First, he loosened his collar.*
- 1b. *Then he took a shot of*
- 1c. *icy vodka.*

In Russian two possible meanings of 'shot' include - 'a glass of vodka' and 'a pile of money'. The preceding context did not bias the interpretation of the ambiguous word prior to the disambiguation region. Stories were presented auditorily and were accompanied by visual panels with four drawings representing two meanings of an ambiguous word and two filler referents. Twenty experimental trials of this kind were presented. Participants' eye movements were recorded as they viewed the displays and listened to the stories. To measure WM the verbal eye-movement WM task (Ivanova & Hallowell, 2012) was used: participants had to visually match short and simple active sentences to one of the four pictures in the visual array and simultaneously remember a distinct set of colors for later recognition. Performance on the this task was monitored solely via eye movements. WM capacity was computed as the average proportion of fixation duration on target color sets in the recognition arrays. 56 native Russian speakers (36 healthy individuals, 20 individuals with NFA) participated in the experiment.

In the disambiguation region (1c) the mean proportion of fixation duration on the target (e.g. 'a glass of vodka') was significantly greater than on the competitor (e.g. 'a pile of money') and on the fillers for both controls ($t(35) = 20.6, p < .001$) and individuals with NFA ($t(19) = 6.7, p < .001$). However, for the NFA group the difference in proportion of fixation duration between the target and the competitor was significantly less than in healthy participants ($t(54) = 5.0, p < .001$), indicating less efficient lexical processing in individuals with NFA. Additionally, individuals with aphasia had reduced general verbal WM capacity compared to healthy controls ($t(53) = 8.2, p < .001$). A significant positive relationship between WM capacity and efficiency of ambiguity resolution was observed only for the aphasia group ($r(17) = .45, p = .05$).

The study demonstrated that both healthy controls and individuals with NFA resolve lexical ambiguity in the disambiguation region as soon as all the relevant linguistic information was provided. Though no significant delay in lexical integration of the correct meaning with the preceding context was observed for participants with NFA, overall, lexical ambiguity resolution was less effective in the aphasia group compared to healthy individuals. For the first time the link between efficiency of lexical processing and WM in NFA was demonstrated: our data suggest that general reduced verbal WM capacity places a limitation on resources available for lexical processing in NFA, making it less efficient than in healthy controls, possibly through insufficient inhibition of irrelevant meaning of the ambiguous word (Gadsby et al., 2008).