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Exploring Speech Segmentation Abilities in People with Chronic Aphasia

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Introduction

A number of studies have demonstrated that healthy infants and adults can segment words from running speech using statistical learning mechanisms (Rebuschat & Williams, 2012). However, little is known about the functionality of word segmentation in aphasia. Recent research suggests that people with aphasia preserve some ability to learn novel words (Tuomiranta et al, 2011) but the initial language learning mechanisms such as word segmentation are still to be addressed. We explored the ability of individuals with chronic aphasia to segment words from running speech via statistical learning.

Methods

The participants were 14 individuals with stroke-induced chronic aphasia and 13 healthy controls matched for age and education. Two word segmentation tasks were administered 1 week apart. Each task included exposure to a continuous speech stream, an artificial language for which only transitional probabilities between syllables provide a reliable cue for word boundaries (Cunillera et al, 2010). Two word segmentation measures were used in each task. The first measure was a two-alternative forced choice test (2AFC test) which demands the discrimination of words of the novel language from non-words composed of syllables never concatenated together in the language. The second measure was a recognition test where the participant was to decide whether a given item was a word of the new language or not. Here, we present our group level results on the first 2AFC test.

Results and Discussion

The mean number of correct responses on the 2AFC test was 59.82 % for the patients and 70.67% for the controls. One sample t-tests evidenced that both the patient group $t(13) = 2.41, p = .032$ and the control group $t(12) = 4.04, p = .002$ performed above chance level. The difference between the groups in their ability to discriminate words from non-words did not reach statistical significance t

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(25) = -1.67, $p = .11$. Thus, at least some individuals with aphasia have retained their ability to segment novel speech input based on transitional probabilities. At the neuroanatomical level, we will discuss how this relates to the integrity of the left dorsal speech processing pathway (posterior superior temporal gyrus - inferior frontal and premotor cortex) that has been related to speech segmentation (Rodríguez-Fornells et al, 2009).

To our knowledge, this is the first study to address statistical learning in speech segmentation in patients with aphasia. The results indicate that this initial language learning mechanism can remain functional even in the face of stroke-induced chronic aphasia.

Table 1. Demographic and clinical data of patients with aphasia

Case	Gender/ Age (years)	Education (years)	Native language	Aphasia type/ severity	Lesion location	Time from stroke (years)
AE	M/ 66	11	Spanish	Anomic/mild ¹	Left MCA stroke	2
JH	M/ 54	16	Catalan/ Spanish ³	Broca/moderate ¹	Extensive MCA stroke/intracerebral hemorrhage (frontal regions, caudate nucleus)	1.7
AF	M/ 69	8	Catalan/ Spanish ³	Fluent aphasia/mild ¹	Left MCA stroke (parietal regions)	2
AM	M/ 72	10	Spanish	Broca/severe ¹	Left MCA stroke (frontal regions, insula)	1.5
RS	M/ 57	8	Catalan/ Spanish ³	Anomic/mild ¹	Left MCA stroke (caudate nucleus, putamen and internal capsule)	1.3
AL	F/ 75	Reading and writing skills only	Spanish	Wernicke/moderate ¹	Left MCA stroke/intracerebral hemorrhage (fronto- temporal regions, insula and basal ganglia)	1.7
CM	M/50	12	English	Anomic/ mild- moderate ²	Left MCA stroke (parietal, bilateral subcortical lesions)	4.5
FS	F/59	12	English	Conduction/moderate ²	Left intracerebral hemorrhage (internal capsule)	6.10
QH	M/61	18	English	Anomic/ mild ²	Left intracranial hemorrhage/ craniotomy	4.7
KM	M/67	16	English	Transcortical motor/ mild-moderate ²	Left MCA stroke	16
BB	M/73	18	Swedish	Anomic/moderate ¹	Right MCA stroke	8
BL	F/63	16	Swedish/ Finnish ³	Fluent aphasia/mild ¹	Aneurysm rupture leading to subarachnoid hemorrhage	7
JS	M/77	15	Finnish	Mixed / mild ¹	Left MCA stroke	3
EP	M/72	18	Finnish	Anomic/ moderate ¹	Left temporal intracranial hemorrhage	3

MCA= Middle cerebral artery.

¹ Boston Diagnostic Aphasia Examination (BDAE).

² Western Aphasia Battery (WAB).

³ Early bilinguals.

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