

Grammatical Complexity Following Right Hemisphere Stroke

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Introduction

Functional imaging, electrophysiological, and ablation studies suggest that the right hemisphere modulates brain arousal and also plays a dominant role in "global" processing. In addition, imaging studies have shown that normal speakers utilize right hemisphere resources when producing or comprehending complex sentence structures. Based on these findings, we posited that people with right hemisphere damage (RHD) would produce less complex speech than healthy adult speakers. This study analyzed grammatical complexity in individuals with RHD and healthy older adults.

Methods

Participants:

- **Right hemisphere damaged individuals (RHD):** samples came from a screening protocol at the VA RR&D Brain Rehabilitation Research Center in Gainesville, Florida.
 - 10 RHD (6 male, 4 female), mean age 63
 - All had suffered a right hemisphere stroke, resulting in unilateral brain damage
 - All were at least four-months post stroke, and were right-handed, native speakers of English
- **The healthy older adults (HOA)** were interviewed using the same protocol and equipment but were seen at the Language Over the Lifespan Lab at the University of Florida.
 - 10 healthy older adults (5 male, 5 female), mean age 77
 - None had a history of neurological disease or language or speech difficulties and all were native speakers of English

Procedure:

Discourse samples were elicited for all participants using a script consisting of formatted questions relating to three pictures of famous people or historical events (landing on the moon, Elvis Presley, and Bill Clinton). Samples were audiotaped and transcribed verbatim. Discourse samples were first broken down into individual utterances and then coded. Coding of the transcripts consisted of:

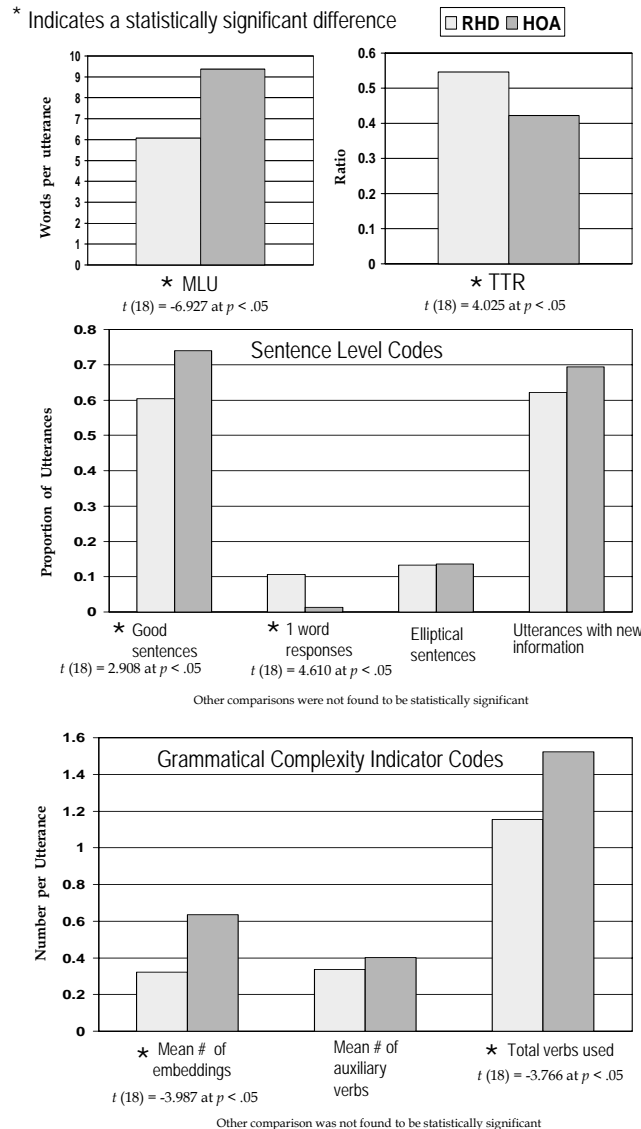
Discourse Scoring:

Sentence Level Codes

- 1- word responses: conversationally appropriate, linguistically and socially acceptable single word answers to questions. ("What kind of pudding do you want?" - *Vanilla.*)
- Elliptical responses: conversationally appropriate, linguistically and socially acceptable answers to questions. ("*Watch TV.*" as a response to "What do you want to do tonight?")
- Good sentences: completely grammatical sentences that were relevant to the ongoing discourse
- Utterances with New Information (UNI). This code provides a measure of proportion of utterances that provided new information to the ongoing conversation.

Grammatical Complexity Indicator Codes

- Embedded sentences are limited to relative clauses
- Auxiliary verbs were counted as a measure of verb phrase complexity
- Total verbs included the matrix verb, verbs in any embedded clauses and infinitives



Analysis

The coded utterances were analyzed using Systematic Analysis of Language Transcripts (SALT, Miller & Chapman, 2000) that provided quantitative data such as mean length of utterance (MLU), and type-token ratios (TTR), that were also used for investigating differences between the groups. SALT also provided tallies of all codes.

Independent samples T-tests were run on all measures by group. All sentence level codes and grammatical complexity codes were divided by total number of utterances before statistical analysis.

Discussion

Right Hemisphere contributions to processing

Imaging studies have shown that normal subjects show increasing activation in the right hemisphere as tasks increase in complexity (Gernsbacher & Kaschak, 2002). Studies have also found that older individuals with fewer processing resources produce less complex speech than those with more intact processing.

Thus, we hypothesized that individuals with RHD would produce language with lower grammatical complexity than adults with no brain damage.

The findings of this study do suggest that the right hemisphere plays a role in creating complex sentences.

We are not suggesting that these findings imply that the RH is contributing directly to grammatical processing. Instead we believe that right hemisphere processes may be a crucial resource for keeping the conceptual representations of two clauses active simultaneously, allowing the production of more complex embedded sentences.

Information Content?

The individuals with RHD also produced shorter responses, as shown by lower MLU and fewer utterances (not shown).

In contrast, the RHD group had a higher TTR than controls, although they produced similar numbers of utterances with new information.

This suggests that the RHD group may have been relying on lexical diversity (e.g., increased numbers of adjectives) rather than embedded sentences, which include more words, to encode similar amounts of information.

This possibility is currently being explored in our lab.

Age Differences between Groups

Although our groups differed in age, we do not believe this is a problem for our findings. Our control group (mean age 77) was older than the RHD group (mean age 63). Grammatical complexity has been found to decrease in adults over 65; consequently, if anything, the RHD group could have produced more complex speech than controls.