

## Real-time production of unaccusative vs. unergative sentences in normal and agrammatic speakers: an eyetracking study

### Abstract

This study examined real-time production of unergative and unaccusative verbs in sentences in 13 controls and 9 agrammatic speakers, using eyetracking. Speakers constructed a sentence, using written words. Results showed that both controls and aphasics showed increased gazes in producing the subject noun phrase in the unaccusative condition as compared to the unergative condition. However, aphasic speakers showed the difference before speech onset, while controls showed the difference during speech. The findings suggest that aphasic speakers are sensitive to the unaccusative-unergative distinction among intransitive verbs, but their time course of sentence planning may be different from that of normal speakers.

### Introduction

Individuals with agrammatic aphasia show greater difficulty producing sentences with more complex verb argument structure (Thompson, 2003). For example, they show greater difficulty producing unaccusative (*float*) as compared to unergative verbs (*bark*) both as singletons and in sentences (Lee, M. & Thompson, 2004). Although both verbs are intransitive, unaccusatives require movement of the theme argument from its base position to the subject position. This renders unaccusatives more complex than unergatives in which subjects are base generated in the subject position. However, little is known about how these difficulties are reflected in on-line processes of sentence planning in agrammatic speakers.

In a recent eyetracking study, Lee, J. & Thompson (submitted) examined real-time planning of verb argument phrases (e.g., the mother is *applying* the lotion to the baby) and adjunct phrases (e.g., the mother is *choosing* the lotion for the baby) in English-speaking agrammatic and normal participants. While both controls and agrammatic speakers did not show reliable differences in off-line measures, their eye movements revealed increased processing cost for adjuncts (reflected by greater looks to the verb and adjunct) as compared to goal arguments. Interestingly, agrammatic speakers showed this difference at an earlier stage of sentence planning than controls, suggesting that while their sensitivity to verb arguments vs. adjuncts is preserved, they may use different planning strategies from normal speakers.

The purpose of this study was to examine real-time production of unergatives (e.g., *the black dog is barking*) and unaccusatives (e.g., *the black tube is floating*) in normal and agrammatic speakers, by tracking their eye movements during a sentence construction task. Specifically, how unaccusativity affects planning of a subject noun phrase (e.g., *black tube*) was examined. It was hypothesized that when a subject noun involves syntactic movement (unaccusative condition), speakers would show evidence of increased processing cost, resulting in increased looks in the unaccusative condition, compared to the unergative condition.

## Methods

### Participants

Thirteen control speakers (age 18-22) and 9 individuals with agrammatic Broca's aphasia (age 35 – 60) participated in this study. All had normal hearing and normal or corrected-to-normal vision. The diagnosis of agrammatic aphasia was based on Western Aphasia Battery (AQ 69-84, Kertesz, 1982), performance on the Northwestern Assessment of Verbs and Sentences (Thompson, experimental version) and spontaneous speech. All aphasic participants were able to read single words.

### Stimuli & Procedures

Ten unergative (e.g., *bark*) and 10 unaccusative verbs (e.g., *float*) were selected and used with an adjective and a noun, as in (1). Between the two conditions, the same adjective was used. In addition, the nouns and verbs were matched in terms of their log lemma frequency (verbs: 1.77 vs. 1.78; nouns: 1.67 vs. 1.67 for unergatives vs. unaccusatives, respectively) and length (verbs: 1.0 vs. 1.1 syllables; nouns: 1.9 vs. 1.9 syllables for unergatives vs. unaccusatives, respectively) [ $p$ 's > .05]. A set of filler structures without a complex noun phrase (e.g., the teacher is selecting a novel for the student) was included to prevent strategic production of the target structures.

- (1) a. The black dog is barking. (unergative condition)  
b. The black tube is floating. (unaccusative condition)

Participants constructed a sentence using a set of computer-displayed written words, as shown in Figure 1. They were instructed to use the verb provided and try to include all words. The positions of the adjectives and nouns were randomized across trials to prevent visual bias. Aphasic participants were familiarized with the noun and verb singletons off-line prior to the eye tracking task to ensure their ability to read and comprehend the word stimuli. All patients attained 90% and above for both nouns and verbs. During the on-line sentence construction task, participants' fixation times to each word were measured in relation to their speech.

## Results

### Production accuracy

While aphasic speakers showed worse performance than controls, neither group showed significant differences between the unergative and unaccusative conditions. Controls showed 95% and 93% correct responses for the unergative vs. unaccusative conditions, respectively [ $t(12) = .94, p > .05$ ]. Aphasic speakers showed 69% vs. 67% for the unergative vs. unaccusative conditions, respectively [ $t(8) = .72, p > .05$ ]. The most dominant error type in aphasic speakers was misplacement of the adjective in both conditions (e.g., *the dog is barking black*).

### Eye movement data

Figure 2 shows the proportion of fixations to each word by speech region for the control (a) and aphasic (b) speakers when correct responses were produced. Both groups showed different viewing patterns between the unaccusative and unergative conditions. Controls showed greater looks to the adjective and noun as compared to the verb prior to

speech onset in both conditions. During the *Adjective-Noun region* (before producing “tire”), controls showed persistent looks to the noun in the unaccusative condition, resulting in significantly greater looks to the noun than to the adjective [ $t(11) = 2.864, p < .05$ ]. However, this difference was not shown in the unergative condition [ $t(11) = 1.782, p > .05$ ]. Aphasic speakers showed greater looks to the adjective than to the noun *prior to speech onset* (before producing “black”) in the unaccusative condition [ $t(8) = 2.50, p < .05$ ]. However, this difference was not reliable in the unergative condition [ $t(8) = .14, p > .05$ ]. The looking patterns were similar in the rest of speech regions between the unaccusative and unergative conditions.

## Discussion

Our data suggest that both normal and agrammatic speakers show qualitatively different eye movement patterns during the processing of unergative vs. unaccusative structures. Both groups showed increased looks when producing a subject noun phrase involved movement of the theme (unaccusative condition) as compared to the agent (unergative condition). Interestingly, while controls showed increased looks to the theme subject noun *during speech*, aphasic speakers showed increased looks to the adjective *prior to speech onset*. Taken together, these findings suggest that (a) the distinction between unergative and unaccusative structures remains preserved in agrammatic sentence production (Lee, M. & Thompson, 2004) and (b) they may use different time course of sentence planning from normal speakers (Lee J. & Thompson, submitted). Further theoretical and clinical implications of these data will be discussed.

## References

- Lee, J. & Thompson, C. K. (submitted). Real-time production of arguments and adjuncts in normal and agrammatic speakers. *Language and Cognitive Processes*.
- Lee, M., & Thompson, C. K. (2004). Agrammatic aphasic production and comprehension of unaccusative verbs in sentence contexts. *Journal of Neurolinguistics, 17*, 315-330.
- Thompson, C. (2003). Unaccusative verb production in agrammatic aphasia: A syntactic account of verb production deficits. *Journal of Neurolinguistics, 16*, 151-167.

Figure 1. A set of sample stimuli

Unergative condition

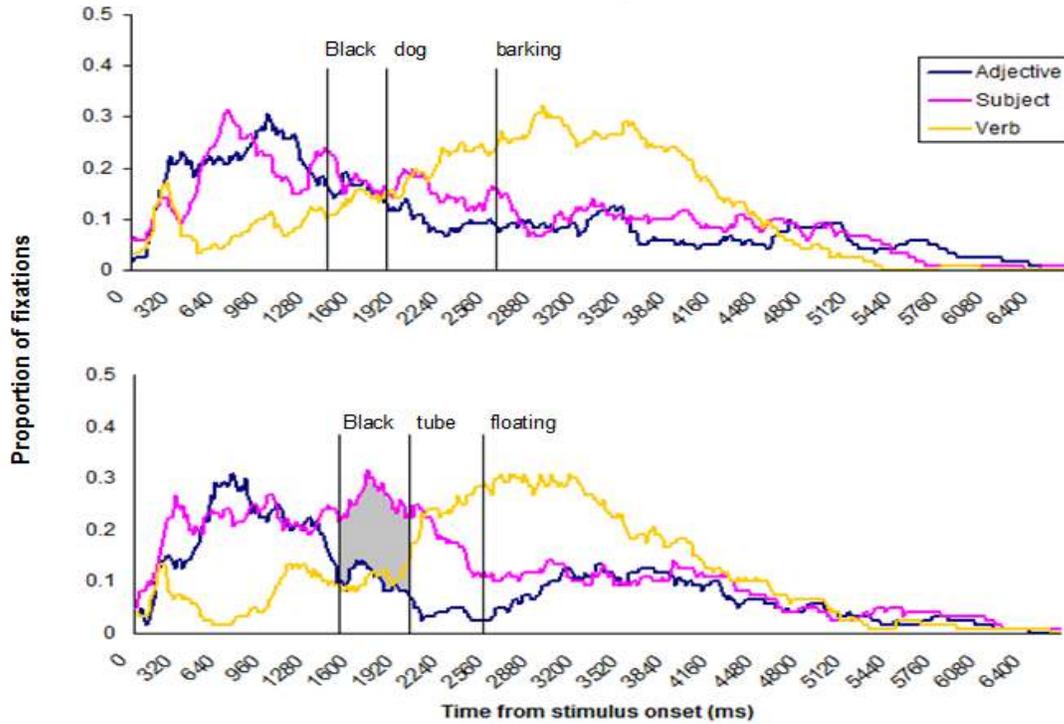
	<b>black</b>
<b>is barking</b>	
	<b>dog</b>

Unaccusative condition

	<b>black</b>
<b>is floating</b>	
	<b>tube</b>

Figure 2. Changes in fixations across successive 4-ms time intervals from stimulus onset during correct production. The vertical lines indicate mean speech onsets of each word.

(a) Controls, unergatives (top) vs. unaccusatives (bottom)



(b) Aphasics, unergatives (top) vs. unaccusatives (bottom)

