



Etiology of Grammatical Errors by Older Adults in a Constrained Sentence Production Task

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ABSTRACT

Aphasics often omit function words, such as determiners and auxiliary verbs, and have difficulty using verbs with noncanonical argument structures or producing complete sentences. In the current study we elicit similar errors from older adults in a constrained sentence production task. We hypothesized that grammatical errors may be heterogeneous in etiology. The objective of this study was to test whether different types of grammatical errors correlated with different cognitive and linguistic abilities. 48 healthy older adults (age > 60) completed a constrained sentence production task and a battery including: vocabulary tests (Shipley, WAIS III), word reading, and working memory (WM) tasks, including the 2-back and digit span backward. The sentence production task required participants to include 3 stimulus words, a transitive verb and 2 nouns differing in animacy, in a sentence. Verbs included agent-theme and experienter-theme verbs with regular morphology, noncanonical theme-experienter verbs (e.g., bored), and irregular past participles (e.g., hidden). The number of sentences including omitted determiners, omitted auxiliary verbs, argument structure errors, or incomplete sentences were compared to scores on linguistic and WM tasks. Omitted determiners were predicted by digits backward and word reading scores. Omitted auxiliary verbs were predicted by 2-back accuracy and vocabulary scores. Argument structure errors and incomplete sentences were both predicted by the Shipley vocabulary task and were highly correlated. These results suggest that function word use relies on both WM and linguistic processing and, as such, may be impaired by damage to either faculty. These results suggest that different aspects of WM and linguistic knowledge are tapped by auxiliary verbs and determiners. In contrast, argument structure errors and incomplete sentences are predicted solely by vocabulary scores. This suggests that grammatical knowledge varies within a population much as vocabulary knowledge does. Thus, different types of grammatical processing tap different aspects of cognitive and language systems.

METHODS

Participants

48 healthy older adults from the Gainesville area, screened for history of stroke, brain pathology or reading deficits
Mean Age: 75.5 (sd 7.3); Education: 16.2 (sd 2.7)

Procedure

In one 90-minute session, participants completed a battery that included 5 verbal working memory (WM) tasks, 3 vocabulary tasks and a constrained sentence production task.

WM Tasks

- digit span backward ($M = 7.4$; $sd 2.8$), max 14
- 2-back accuracy ($M = .92$, $sd = .09$)

Vocabulary Tasks:

- WAIS III Vocabulary ($M = 63.3$; $sd 6.3$), max 70
- Shipley Vocabulary ($M = 35.8$; $sd 3.2$), max 40
- Word-Reading—100 words from the WRAT & Woodcock-Johnson Reading lists ($M = .87$; $sd .08$)

Constrained Production Task

A 3-word stimulus was presented vertically on the computer screen. Participants had to produce a grammatical sentence that included all 3 words. Stimuli disappeared from the screen when the computer detected a response.

Stimuli included a verb in past participle form, an animate and an inanimate noun. The verb was always in the center position; the position of animate and inanimate nouns varied by item and subject. Nouns were chosen to be plausible arguments of a particular verb.

Verb types were chosen to stress the sentence production system in different ways: Irregular past participles forced the use of a complex verb phrase (e.g., The janitor had hidden the stain.), theme-experienter verbs required the use of a passive sentence when an animate subject was desired (e.g., The student was depressed by the exam.), other verb types allowed the use of simple past tense sentences with animate subjects (e.g., The butler stirred the juice. The teacher enjoyed the story).

Error types

Argument structure errors: *The student depressed the exam.*

Incomplete sentences: *The bored opera drummer.*

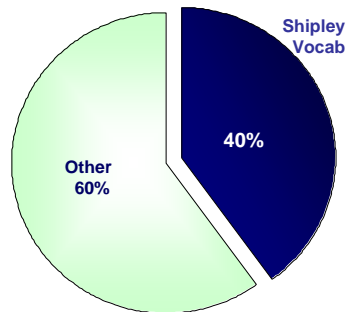
Omitted auxiliary verbs: *The juice poured by the butler.*

Omitted determiners: *Housewife was shocked by the sculpture*

NOTE: Only UNCORRECTED errors of each type were counted!

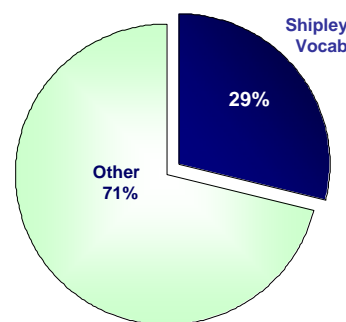
RESULTS

Argument Structure Errors



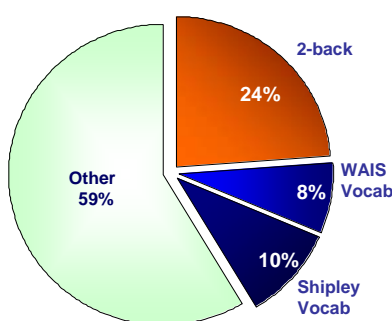
- 44% of participants (21) produced these errors
- Predicted by Shipley Vocabulary $r^2 = .40$, with Outlier. $r^2 = .26$, without Outlier*

Incomplete Sentences



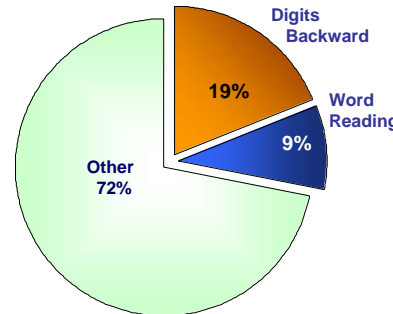
- 25% of participants (12) produced these errors
- Predicted by Shipley Vocabulary $r^2 = .29$, including Outlier. $r^2 = .26$, excluding Outlier*

Omitted Auxiliary Verbs



- 25% of participants (12) produced these errors
- 41% of variance accounted for by: 2-back accuracy ($r^2 = .24$)
WAIS Vocabulary ($r^2 = .08$)
Shipley Vocabulary ($r^2 = .10$)

Omitted Determiners



- 60.9% of participants (27) produced these errors
- Sentence-initial determiners were most vulnerable
 - 162 S-initial, 13 S-medial
- 28% of variance accounted for by:
Digit Span Backward (19%)
Word Reading (9%)

* One subject proved to be an outlier on many of the measures included here: word reading, argument structure errors, incomplete sentences (as well as on morphological substitutions of verbs on our companion poster). Although the subject reported no reading problems, these findings are similar to the error patterns we have found in school-aged dyslexics.

Summary

There was considerable shared variance between: omitted auxiliary verbs, incomplete sentences, and argument structure errors, and all were predicted by vocabulary size. Omitted auxiliary verb errors were also predicted by WM (2-back task).

Determiner errors patterned differently and did not correlate with other types of grammatical errors, although they still correlate with knowledge of language & WM measures.

CONCLUSIONS

In this study, we show that agrammatic production can be elicited in the laboratory from healthy speakers. We also demonstrate that language ability and verbal WM contribute to the grammatical aspects of sentence production in older adults. One interesting finding is the complete lack of age effects, indicating that this aspect of sentence production is resilient in the face of age-related declines in other aspects of sentence production, such as grammatical complexity. Two primary patterns are evident in the data: constructional errors are predicted by vocabulary scores, but agrammatic errors are predicted by both vocabulary and WM measures.

Constructional errors

Scores on the Shipley vocabulary test predict significant portions of variance in error rates in argument structure and incomplete sentences. This is consistent with theoretical assertions that argument structures of verbs may be part of the meaning of a verb and, therefore, should correlate with word knowledge.

Syntactic knowledge (e.g., what 'counts' as a grammatical sentence) is also highly related to word knowledge here. Apparently, awareness of grammatical constraints varies in the population much as word knowledge does. We suspect increased exposure to language leads to both higher vocabulary scores and to more robust representations of grammatical structures. These findings contradict assertions that grammatical knowledge is relatively uniform within a language community and that it is relatively independent of semantic knowledge.

Agrammatic errors

Error types that mimic agrammatic production, omitted auxiliary verbs and determiners, are related to vocabulary size and WM scores. This suggests that both types of processing are required for accurate usage of these words. Consequently, damage to either system may make using these grammatical formatives more difficult. Imaging studies show that WM tasks, especially the 2-back, require simultaneous activation of posterior, inferior frontal lobe and inferior parietal lobe. Thus, providing function words on demand may depend on the ability to simultaneously activate frontal and posterior language areas. This may explain the vulnerability of function words in brain damage.

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