



Etiology of the Paraphasias of Older Adults In a Constrained Sentence Production Task

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ABSTRACT

Individuals with language pathologies often substitute related words for those they intend to include when speaking. In the current study, these errors are elicited in the responses of older adults in constrained sentence production tasks. Our objective was to determine if older adults' omissions, semantic substitutions and morphological alterations of stimulus words were related to individual differences in working memory (WM) or language ability. 48 healthy adults over age 60 completed a battery of 8 cognitive and linguistic tasks that included the WAIS III vocabulary test, a word-reading task, and the 2-back, a WM task activating frontal and parietal lobes. Participants also completed a sentence production task in which they produced sentences from 3 stimulus words, a transitive verb and 2 nouns differing in animacy. Dependent variables included the proportion of sentences produced in which stimulus words were replaced by orthographically similar words (form-based paraphasias), by semantically or totally unrelated words, or by morphological substitutions of the target words.

Word reading accounted for 37% of the variance in form-based paraphasias, 20% of the variance in morphological substitutions of verbs, and 23% of the variance in morphological substitutions of nouns. Scores on the 2-back WM task account for 17% of the variance in target word omissions, suggesting that less efficient fronto-parietal connections supporting WM contribute strongly to the ability to include the precise target word in the sentence. Furthermore, age contributes both to the stimulus omissions and the ability to retrieve the exact form of the verb stimulus. This may signal that age-related encoding deficits contribute to these types of errors. By far the most successful predictor of performance on this task was Word Reading ability, a measure of the ability to accurately access phonology from print. Thus, individual differences in vocabulary size, as well as WM and age, contribute to the ability to include the 3 stimulus words as shown in a spoken response.

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

- 2-back accuracy ($M = .92$, $sd = .09$)

Vocabulary Tasks

- WAIS III Vocabulary ($M = 63.3$; $sd 6.3$), max 70
- 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 were instructed 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-experiencer 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).

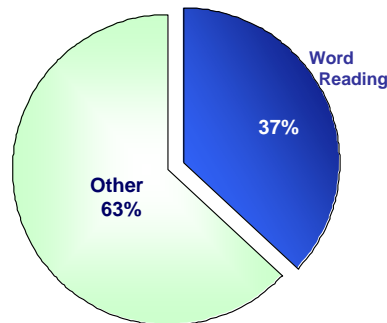
Error types

Reading errors: The therapist disguised the story. (target: disgusted)
Omitted stimuli: The immigrant disliked the elevator. (target: escalator)
Morphological substitutions of verbs: The jockey ate the carrot. (target: eaten)
Morphological substitutions of nouns: The minister admired the photographer. (target: photograph)

NOTE: Only UNCORRECTED errors have been included here!

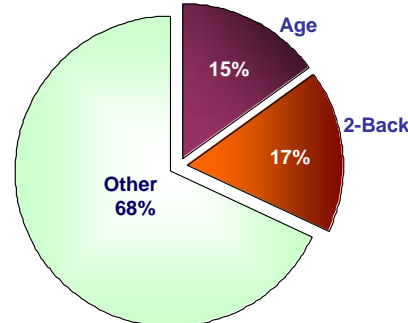
RESULTS

Form-based Paralexias



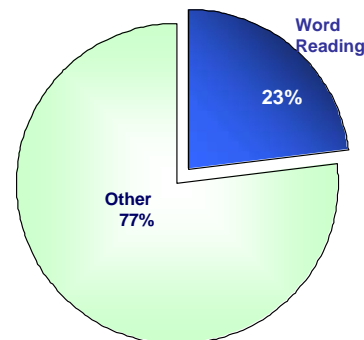
- Orthographic form-based errors
- 31% of participants (15) made these errors
- Predicted by Word Reading
 $r^2 = .20$, without Outlier
 $r^2 = .37$, with Outlier

Stimulus Omissions



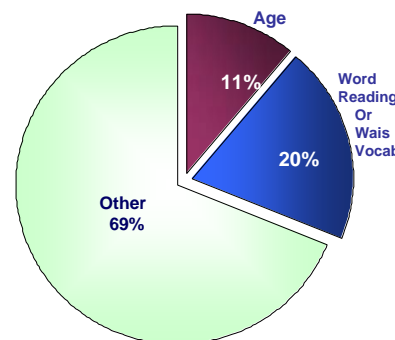
- Included semantic paraphasias and outright omissions of Nouns & Verbs
- 40% of participants (19) produced these errors
- 32% of variance predicted by Age and 2-back accuracy

Morphological Substitutions-Nouns



- 19% of participants (9) made these errors
- 23% of variance accounted for by Word Reading

Morphological Substitutions-Verbs



- 30% of participants (14) made these errors
- 31% of variance accounted for by: Age and **either** WAIS vocabulary or Word Reading

CONCLUSIONS

In this study we show that aphasia-like errors can be elicited from healthy older adults in an experimental setting. Further, we demonstrate that some error types may be related to age or WM deficits, but that many of these errors may also be related to differences in knowledge of language and reading ability. These findings are discussed below.

Age effects

Age effects in this study are limited to 2 error types: stimulus omissions and morphological substitutions of verbs. These error types may both reflect age-related encoding deficits; for example, individuals may begin to speak before they fully encode the meaning and form of the stimulus words. This could lead to: morphological substitutions of verbs if the exact word form is not encoded, semantic paraphasias if only the meaning of the word is encoded, or stimulus omissions if no information is encoded about one of the stimulus words.

WM effects

Only Stimulus Omissions are related to WM ability (i.e., 2-back accuracy). We suspect that both this task and the 2-back require the ability to sustain complex processing over time; therefore, both tasks would be vulnerable to transient failures of attention. As above, failures of attention may lead to incomplete activation of one or more stimulus words. In this way, failure to attend to the phonological form of a word could lead to a semantic paraphasia, while a complete failure to attend to a stimulus word would lead to its omission.

Word knowledge effects

Word Reading significantly predicts the frequency of three of these error types, but the word reading task is complex and minimally requires both word recognition ability and ability to access the exact phonological form of stimulus words. We postulate that different subtypes of errors relate to different task demands of the Word Reading task. For instance, form-based paraphasias are likely due to failures to recognize a word, while morphological substitutions may be related to failure in the activation and use of the exact morphological form shown in the stimulus.

However, there is no correlation between morphological substitutions of verbs and nouns, suggesting that other factors may contribute to the verbatim use of these words. Considering that vocabulary scores predicted morphological substitutions of verbs as well as Word Reading did, encoding and then using the correct inflected form of the verb may have required higher level word knowledge (e.g., an awareness of the difference between a simple past and past participle form) that was not necessary in noun use.

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